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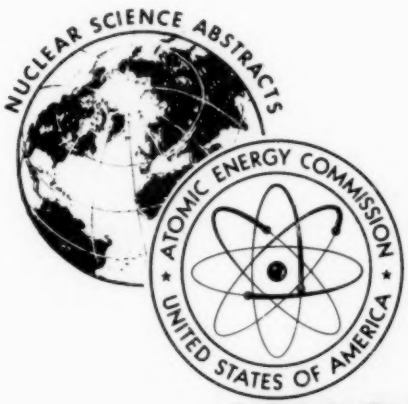

NUCLEAR SCIENCE ABSTRACTS

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Volume 19 Number 1

Abstracts 1–1987

January 15, 1965

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NOTICE

The following changes have been incorporated in *Nuclear Science Abstracts* beginning with Volume 19, Number 1:

(1) Report Number Indexes

a. Plans for future cumulations are presented on Page i. Indexes for Volumes 1–18 will be the final completely cumulative report number index. Indexes for Volumes 1–15 will be reissued with the latest known public availability at the end of 1965. After that time, Volumes 1–15 will not be reissued. Indexes for Volumes 16–19 will be cumulated at the end of Volume 19.

b. A modification of the system for numbering conference papers is discussed in the introduction.

(2) Modifiers for Physics Entries

If the text structure of the modifier does not indicate whether the reference is experimental or theoretical, a symbol "E" or "T" or "E/T" is given.

(3) Scope Definitions

a. The scope of "Physics" has been redefined to more clearly indicate the interest in gravitational collapse, solar and stellar phenomena, field theory and quantum electrodynamics, and auroral or ionospheric phenomena.

b. Under each of the elements Molybdenum, Rhenium, Tantalum, and Tungsten the scope has been broadened to include metallurgy of the element or its alloys, compounds, or systems.

(4) Subject Category Definitions

The subcategory "Radiation and Radiochemistry" has been separated into two subcategories "Radiation Chemistry" and "Radiochemistry." A new subcategory "Radiation Effects" has been introduced under the category "Instrumentation."

CORRECTION

NSA Vol. 18, No. 24, Index page 129. Availability entry for report number BNL-325, 2nd Edition, Supplement 2, Volume 1, abstract 44726 should be: Dep.; $2.50(fs) GPO.

Volume 19, Number 1, January 15, 1965

NUCLEAR SCIENCE ABSTRACTS

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Published by the USAEC Division of Technical Information Extension, Robert L. Shannon, Extension Manager.

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Volume 19, Number 1 January 15, 1965

NUCLEAR SCIENCE ABSTRACTS

BIOLOGY AND MEDICINE

General

Refer also to abstract 853.

1 (HW-81746) HANFORD RADIOLOGICAL SCIENCES RESEARCH AND DEVELOPMENT ANNUAL REPORT FOR 1963. C. C. Gamertsfelder and J. K. Green, eds. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Jan. 1964. Contract AT(45-1)-1350. 386p. Dep.; $7.00(cy), 6(mn) OTS.

Research and development in the radiological sciences are reported in 81 papers. Separate abstracts were prepared for 73 of the papers. The remaining 8 papers were previously abstracted for NSA and appear as abstracts 17: 41022, 18: 2390, 3398, 8078, 8642, 19875, 23834, and 31422. (M.C.G.)

For abstracts of individual papers see: 2, 3, 4, 19, 20, 25, 26, 27, 28, 29, 30, 31, 69, 186, 187, 214, 215, 286, 340, 341, 342, 343, 424, 425, 426, 427, 527, 528, 529, 602, 603, 604, 605, 606, 620, 621, 622, 644, 645, 646, 647, 681, 682, 683, 684, 685, 686, 687, 688, 763, 764, 765, 766, 767, 768, 923, 924, 925, 926, 1033, 1034, 1035, 1036, 1037, 1038, 1039, 1040, 1041, 1042, 1548, 1812, 1944, and 1945.

2 (HW-81746(p.2.32-5)) FAST NEUTRON MEDICAL RESEARCH FACILITY. W. C. Roesch, K. L. Swinth, and L. L. Nichols (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

A fast-neutron medical research facility employing a 14-Mev neutron generator such as used for activation analysis is being prepared for use by the University of Washington. (auth)

3 (HW-81746(p.5.16-21)) AN INTRATHORACIC PRESSURE MONITOR. N. S. Porter (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Physiological pulmonary function studies are performed at the Biology Inhalation Toxicology Laboratory. During the studies, it is desirable to be able to measure the intrathoracic pressure of animal subjects. Measurements must be obtainable either in the esophagus or in the bronchia itself; typical pressures, in centimeters of water, vary from animal to animal and even vary with time in the same subject. A suitable pressure detection measuring and recording system was developed to permit satisfactory experiments to be carried out. The monitor measures thoracic pressure for indefinite periods during the investigative work. A small pressure transducer, which is attached to the end of an insulated cable, is inserted into the esophagus of the animal. Pressure changes are translated into frequency modulated signals that are transmitted through the cable to a control unit and discriminated by appropriate circuitry. The changing d-c levels are calibrated in terms of pressure changes in centimeters of water and recorded with standard recording equipment. The transducer employs a single transistor in a circuit that requires 8.4-v d-c at 2.5 ma or 21 mw. The batteries employed can power the circuit continuously for about 900 hr. (auth)

4 (HW-81746(p.5.22-4)) AN AUTOMATIC ENTOMOLOGICAL SPECIES COUNTER. N. S. Porter and E. M. Sheen (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

During the study of radiation effects on entomological species such as the Tribolium casaneum and confusum, it is necessary periodically to count colony populations. By hand, such counts are tedious and time consuming; similarly, photographic methods require laborious techniques. An automatic counter for performing such tasks was developed. The instrument counts whole colonies of the species being investigated. (auth)

5 (UCRL-11387(Suppl.)) SUPPLEMENT TO BIOLOGY AND MEDICINE SEMIANNUAL REPORT, SPRING 1964. (California. Univ., Berkeley. Lawrence Radiation Lab.). Contract W-7405-eng-48. 54p. Dep.; $3.00(cy), 1(mn) OTS.

Separate abstracts were prepared for four sections of this report. (C.H.)

For abstracts of individual papers see: 6, 76, 279, 280, 347, 348, 417, 429, 434, 435, 865, 930, 962, and 1562.

6 (UCRL-11387(Suppl.)(p.14-18)) ELECTRON MICROSCOPY OF SINGLE-STRANDED DNA: CIRCULARITY OF ϕX-174 DNA. David Freifelder, Albrecht K. Kleinschmidt, and Robert L. Sinsheimer (California. Univ., Berkeley. Lawrence Radiation Lab.).

The DNA of coliphage ϕX-174 is single-stranded and apparently also circular. This latter point, which is based upon the resistance of the DNA to digestion by exonucleases, was confirmed by electron microscopy of DNA molecules adsorbed onto protein monolayers. (auth)

7 (JPRS-26542) STUDIES IN RADIATION SICKNESS TREATMENT. Translated from Med. Radiol., 9: No. 6, 19-21; 43-7(June 1964). 15p. (TT-64-41800). $1.00(OTS).

Separate abstracts were prepared on two articles included in this translation. The third article was abstracted previously in NSA 18: 33413. (C.H.)

For abstracts of individual papers see: 217 and 218.

8 (JPRS-26692) PLANT PHYSIOLOGY AND PATHOLOGY AND AGRONOMICAL PROBLEMS OF THE SOVIET EAST. Translated from Izv. Sibirsk. Otd. Akad. Nauk SSSR, No. 4, Ser. Biol.-Med. Nauk, No. 1, 1963. 57p. (TT-64-41949). $3.00 (OTS).

Separate abstracts were prepared for two articles trans-

lated from the Russian journal. One article was previously abstracted and appeared in NSA as 18: 31170. Other articles discuss plant physiology and soil problems of Serbia. (C.H.)

For abstracts of individual papers see: 37 and 78.

9 (JPRS-26725) RECENT WORKS ON "SKIN VISION," THE CENTRAL NERVOUS SYSTEM, AND RADIATION SICKNESS. Translated from Byul. Eksperim. Biol. i Med., 57: No. 8, 6-9; 13-20; 34-8; 60-8(1964). 39p. (TT-64-41982). $2.00 (OTS).

Separate abstracts were prepared for two articles translated from the Russian journal. Translations of other articles discuss nervous stimulation, the sensitivity of skin to external stimuli, the optic and skin perception of light in man, and the sensitivity of rabbits to ultra-high-frequency electromagnetic fields. (C.H.)

For abstracts of individual papers see: 219 and 220.

10 (JPRS-26757) REPORTS ON DEVELOPMENTS IN BIOLOGICAL SCIENCES. Translated from Nauchn. Dokl. Vysshei Shkoly, Biol. Nauki, No. 2, 80-4; 88-90; 91-3(1964). 16p. (TT-64-51014). $1.00(OTS).

Separate abstracts were prepared for two articles translated from the Russian journal. (C.H.)

For abstracts of individual papers see: 221 and 222.

11 QUANTUM PROCESSES IN PHOTOSYNTHESIS. G. Wilse Robinson (California Inst. of Tech., Pasadena). Ann. Rev. Phys. Chem., 15: 311-48(1964).

A model for quantum processes in photosynthesis in land plants and algae is discussed. Topics covered include: the Blinks effect and Emerson effect, structure of photosynthetic apparatus, location of the pigment system, the photosynthetic unit, the bulk pigments, energy traps, chlorophyll fluorescence, transfer of energy to the sinks, the primary photochemical steps, and the electronic structure of chlorophyll. (M.C.G.)

12 WORK IN THE FIELD OF RADIOBIOLOGY AT THE INSTITUTE FOR BOTANY AND MICROBIOLOGY. F. Schwanitz, A. Feldmann, H. Kern, H. Mueller, G. Reuther, H. Schander, and K. H. von Wangenheim (Kernforschungsanlage, Julich, Ger.). Atompraxis, 10: 438-41 (Sept.-Oct. 1964). (In German)

Genetic, cytological, physiological, and biochemical problems of radiobiology were investigated. The different radiosensitivity of species, varieties, and mutations, analysis of irradiated cells in dependence on given growth stages and physiological states, the genetic results of radioinduced mutations in populations of cross fertilizations, analysis of interspecific genetic transformations between micro-organisms, and the physiology of Ca–Sr metabolism in plants were the principal areas under study. Some of the results of these studies available at the present time were reported. (tr-auth)

13 PRESERVATION OF VIABILITY OF FROZEN HUMAN MARROW. H. M. Pyle and Hilda F. Boyer (Protein Foundation, Jamaica Plains, Mass.). Bibliotheca Haematol., No. 19, 89-96(1964).

While autologous frozen bone marrow can protect animals from the effects of lethal irradiation, the human response to autologous frozen marrow transplantation is variable. To preserve human bone marrow with some assurance that it will repopulate a depleted marrow space, it is necessary to have some criteria of cell viability other than the patients' clinical responses to transfused marrow. In this report it is shown that human bone marrow, preserved at −84°C, can maintain essentially the same degree of viability in vitro as fresh marrow. This degree of viability is maintained even after storage periods of 9 months, the longest storage period to date. Viability is determined by the incorporation into the DNA during cell mitosis of ^{3}H-thymidine and subsequent autoradiography. This gives no measure of the viability of non-mitosing cells, but it does give a semiquantitative indication of the viability of the cells. The marrow is obtained from the posterior ileum and is aspirated through a semiclosed system into equal volumes of freezing mixture, each marrow aspirate containing approximately 16 ml of marrow. The freezing mixture consists of 20% dimethyl sulfoxide (DMSO), 1% glucose, and 60 units/ml heparin in Eagle's medium, and adjusted to pH 7.8 with $NaHCO_3$. The cell recovery by the method of preservation is satisfactory, the average cell loss from the time of donation of the marrow, through storage and reprocessing for transfusion, averaging 22%. The more active marrows with more immature cells withstand the trauma of freezing and thawing better than more mature cells. Above a 40% (wt/volume) concentration, DMSO had a direct lytic action on red cells. Preliminary toxicity tests with DMSO in rabbits suggest this is the cause of death in the acute and in chronic toxicity studies. In humans, concentrations up to 2.5% DMSO were administered to 8 patients. Follow-up studies up to one year have shown no changes in liver function, kidney function, or blood formation. (BBB)

14 COMPARATIVE STUDY OF PHLOEMIC MOVEMENT OF CHLORINE ^{36}Cl AND PHOSPHORUS ^{32}P. Michel Penot (Université, Strasbourg). Compt. Rend., 259: 868-70(July 27, 1964). (In French)

The physiologic difference of the phloemic transport of Cl^* and P^*, under the influence of cinetine, was established in a defoliation experiment. In defoliation (with the exception of the leaf under test), the cleaning of the donator leaf is stimulated for P and inhibited for Cl. The stimulating action of transpiration on the movement of Cl indicates the existence of a sweep of the Cl by the transpiratory current, whose action without effect for P shows a significant phloemic retention of this element. (tr-auth)

15 ^{35}S LABELING BY ISOTOPE EXCHANGE OF ORGANIC SUBSTANCES WITH ANTITUBERCULAR ACTIVITY. C. Chiotan, I. Zamfir, and L. I. Ciplea (Institutul de Fisica Atomica, Bucharest). Rev. Roumaine Chim., 9: 195-201(Mar. 1964). (In French)

The labeling of amidazine (thiamide, 1314 Th) and of tebezone I (Th 1698) was carried out by isotope exchange. The ^{35}S used was in elementary form, dissolved in trichlorethylene. p-Xylene was the solvent for amidazine and glacial acetic acid for tebezone I. Labeling took place in an oil bath at the boiling point temperatures of these solvents (136 and 118.2°). In the case of amidazine the greatest yield from isotopic exchange, as well as the best radiochemical product, was obtained when the exchange took place over a period of ten hours. For tebezone, in general, the amount of the exchange product increased with the temperature and duration of exchange but the labeled product had a lower (3 to 6°) melting point than that of the unlabeled tebezone, thus necessitating controlling the temperature carefully. This was also the cause of lower yields and diminished purity of this substance in comparison with labeled amidazine. (BBB)

16 GENETICS TODAY. PROCEEDINGS OF THE XI INTERNATIONAL CONGRESS OF GENETICS, THE HAGUE, THE NETHERLANDS, SEPTEMBER 1963. VOLUME 1. S. J. Geerts, ed. Oxford, Pergamon Press, 1963. 337p.

Abstracts of contributed papers, demonstrations, and films from the Congress are presented. The following categories are included: complex loci, recombination, molecular and microbiol genetics, gene action, mutagenesis, cytology, cytogenetics, cytotaxonomy and experimental taxonomy, population genetics, developmental genetics, immunogenetics, plasmatic inheritance, plant genetics and breeding, animal genetics and breeding, human genetics, human cytogenetics, and dermatoglyphics. (H.M.G.)

17 PHYSICAL PROCESSES IN RADIATION BIOLOGY. Proceedings of an International Symposium Held at Michigan State University, May 6-8, 1963. Leroy Augenstein, Ronald Mason, and Barnett Rosenberg, eds. New York, Academic Press, 1964. 390p. (CONF-381)

Twenty papers are included. Separate abstracts were

prepared for ten; three others were previously abstracted in NSA (17: 12133, 18: 8077 and 10765). (H.M.G.)

For abstracts of individual papers see: 62, 179, 180, 181, 411. 467, 468, 469, 1190, and 1191.

Ecology

18 (EUR-1842.i) STUDIO DELLA BIOLIGIA DEI PESCI DEL LAGO MAGGIORE, ALLO SCOPO DI RACCOGLIERE QUELLE INFORMAZIONI CHE PERMETTANO DI PREVEDERE LE EVENTUALI INTERAZIONI TRA QUESTI ANIMALI E LA RADIOATTIVITA PRESENTE NELLE ACQUE DEL LAGO (ANNO 1963). (Study on the Biology of the Fish in Lake Maggiore With the Aim of Collecting Data as a Basis for Forecasting the Possible Interactions Between These Fish and the Radioactivity Present in the Lake Water (Year 1963)). (Italy. Istituto Italiano di Idrobiologia, Pallanza). 1964. 13p. Dep.(mn)

As in the preceding year, particular attention has been paid to the biology of Coregonus species (lavarello and bondella) in the Lago Maggiore. The diminution in size of the bondella, already evident in the year 1962 as compared with 1961, was accentuated in 1963 and is seen also in the lavarello. The phenomenon, almost certainly due to increased inter- and intraspecific competition, is accompanied by a retardation in sexual maturity. The lavarello at present maintains a strong numerical superiority only in the most northerly region of the lake, probably as a result of competition with the bondella. During the winter season, benthonic organisms appear in notable quantity together with copepods in the food of the bondella. During the growth period of Coregonus, differences can be found in the importance of different planktonic organisms as food when compared with the previous year. The preponderant contribution of Daphnia hyalina remains unaltered. The bondella shows a greater relative fecundity than the lavarello, with smaller eggs. In both of these Coregonus species, females breeding for the first time exhibit a relative fecundity equal to that at the more advanced age, but with considerably smaller eggs. On evidence from the recapture of about 20% of the 500 lavarello marked in 1962, it is clear that the population that reproduces in the region of outflow of the Ticino into the lake is found later in the whole area of distribution of the species but with decreasing density towards south. A study of the shad (Alosa fallax lacustris) was begun, using the same methods as those employed for Coregonus. The study of the biology of the perch (Perca fluviatilis) has revealed the predominance of the age group 1+ (of first maturation). The food of young individuals in winter, compared with that during the rest of the year, shows a diminution in insect larvae and an increase in cladocerans. (auth)

19 (HW-81746(p.2.4-5)) HUMAN UPTAKE OF Cs^{137} FROM REINDEER MEAT. H. E. Palmer (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Humans who eat reindeer meat absorb most of the ^{137}Cs it contains. Cooking was found to remove half or more of the ^{137}Cs from the meat. (auth)

20 (HW-81746(p.3.86-94)) COLUMBIA RIVER SEDIMENT AND TRANSPORT STUDIES. R. W. Perkins (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

The fate of radionuclides that are introduced into the Columbia River in reactor effluent water is of continuing interest. A project is presently underway in cooperation with the U. S. Geological Survey to study the Columbia River transport of these radionuclides, including their adsorption, sedimentation, translocation, and uptake by inorganic and organic detritus. General observations of the study are described. (auth)

21 (ORO-620) RADIOACTIVITY TRANSPORT IN WATER—ENVIRONMENTAL BEHAVIOR OF NITROSYLRUTHENIUM (thesis). Technical Report No. 3. Albert H. Story and E. F. Gloyna (Texas. Univ., Austin. Environmental Health Engineering Research Lab.). June 1, 1963. Contract AT(11-1)-490. 107p. Dep.; $4.00(cy), 2(mn) OTS.

Submitted by Albert H. Story.

Nitrate and nitrite complexes of nitrosylruthenium were prepared and identified by paper-partition chromatographic techniques. These materials were subjected to various conditions simulating changes in an aquatic environment, namely, variations in pH, chlorides, and sulfides. Ionic characteristics of the various complexes were evaluated with the aid of ion-exchange resins. The affinity of nitrosylruthenium complexes for clays, bottom sediments, and organic debris was investigated. The effects of chlorides, sulfides, hydrogen-ion concentrations and various cations on exchange behavior of the nitrosylruthenium complexes were investigated. Intermediate and end products were determined by use of paper-partition chromatography, absorption spectroscopy, radioactive isotope tracers, x-ray diffraction, and chemical analyses. The chemical data indicate that nitrosylruthenium exists in the form of cations, anions, or neutral species. In the presence of chlorides, the trichloride, $RuNOCl_3$, is formed. At pH ranges of natural waters there is a slow conversion of nitrates and chlorides to hydroxides so that in natural streams nitrosylruthenium hydroxide, $RuNO(OH)_3$, would be the predominant form. The trichloride may be of more importance in marine environs and in animal intestines where chloride concentrations are much higher than in fresh waters. A laboratory scale-model aquatic ecosystem was designed to measure the distribution of nitrosylruthenium complexes among the various components of the system. The major components of the system included water, bottom sediments, suspended material, and macroörganisms. Activity in the form of nitro and nitrato nitrosylruthenium was added to the system. An inventory after 35 days showed over half the ruthenium activity to be associated with bottom sediments. The ecosystem data indicate that organic detritus as well as living plants concentrate nitrosylruthenium; however, dead plants took up more nitrosylruthenium than did living plants. Tests showed that most of the uptake of ruthenium by living organisms was due to surface adsorption. (auth)

22 (JPRS-25966(p.28-41)) THE PROBLEMS OF RADIOECOLOGY OF HYPONEUSTON. Yu. P. Zaitsev and G. G. Polikarpov. Translated from Okeanologiya, 4: 423-30 (1964).

The term hyponeuston is applied to the complex of microörganisms dwelling in the 0 to 5 cm of sea water directly under the surface-tension film. Some of the basic problems involved in radioecological studies of hyponeuston organisms are discussed. It is pointed out that the surface of the seas and oceans is a more efficient collector of radioactive aerosols than the land surface. By concentrating the radioactive substances, the hydrobionts of the hyponeuston create sources of incorporated radioactivity and become links in the migration of radionuclides both into the sea and to land. Possible effects of radioactivity on fish reserves are discussed. (C.H.)

23 IMPORTANT HYGIENIC CONCEPTS OF RADIATION FROM THE AREA OF ECOLOGY. A. H. Frucht and F. Koessler (Institut fuer Angewandte Physiologie, Akademie fuer Sozialhygiene, Arbeitshygiene, und Aerztliche Fortbildung, Berlin). Z. Ges. Hyg. Ihre Grenzgebiete, 7: 567-71(Aug. 1961). (In German)

There are several units and relations that are important to the problem that radiation poses for ecological studies. The biomass unit is an expression of the ratio between the fresh or dry weight of a living organism to its volume at a given instant of time. It is expressed as g/cm^3. Its daily increase in magnitude is a measure of biological productivity. The term biosphere encompasses the hydrosphere, lithosphere, and lower atmosphere where life processes are carried out. The biotope is the naturally bounded living area where organisms of similar types live. Examples are beaches, pools, swamps, etc. Biozoonose is the community relation that exists between plants and animals of a biotope. Biocycles represent biological interchanges. The entry of radioactive elements into one or

more of the biotopes or biozoonoses soon leads to their distribution throughout the entire complex of living organisms. Specific activity is often used as a measure of radioisotopic contamination of organisms or their surroundings, while the ratio of these units expresses the enrichment factor or contamination of the living organisms relative to their environment. Whether the concentration of radioelements will reach a maximum enrichment value, or saturation, will depend on the type of element, the organism, and the concentration in the environment itself, and the degree of saturation will vary with each of these factors. Radioisotopes can be taken up by one or more of several ways, such as adsorption, inhalation, ingestion, or absorption. (BBB)

24 PRIRODNAYA RADIOAKTIVNOST BIOSFERY. (Natural Radioactivity of the Biosphere). L. A. Pertsov. Moscow, Atomizdat, 1964. 315p.

The genesis of natural radioactivity in a biosphere is discussed, and physical and biochemical properties of natural radioisotopes are analyzed. A review is given of the radioactivity of rocks, soils, seas, fresh water basins, plants, animals, and the human body. Cosmic rays and ionizing radiation in the biosphere are discussed, and the mean radiation dose to tissues is estimated. (R.V.J.)

Metabolism, Tissue Distribution, and Toxicology

25 (HW-81746(p.2.9-12)) A SCINTILLATION COUNTER FOR IN VIVO DETECTION OF PLUTONIUM. B. I. Griffin and W. C. Roesch (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

A scintillation counter was constructed for in vivo studies of plutonium deposited in the lungs. The counter detects x rays and gamma rays from plutonium's uranium and americium daughters. The sensitivity is in the range 10 to 100 nanocuries. (auth)

26 (HW-81746(p.2.12-16)) DETERMINATION OF P^{32} IN VIVO. H. E. Palmer (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). (HW-SA-3323)

A transmission proportional counter and a NaI(Tl) scintillator operated in coincidence for detection of ^{32}P beta rays emitted from the head were found to be better for in vivo measurements than a bremsstrahlung counter. The background was lower and much less variable from person to person. Relatively little shielding was required. (auth)

27 (HW-81746(p.2.16-18)) SHADOW-SHIELD WHOLE-BODY COUNTER. H. E. Palmer (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Calibrations for ^{24}Na, ^{132}I, and ^{137}Cs were made. The discrepancy in measurements of potassium losses of kidney patients was resolved. Differential scanning results for ^{132}Cs are presented. (auth)

28 (HW-81746(p.3.12-13)) BIOASSAY MEASUREMENTS BY DIRECT COUNTING ON A MULTIDIMENSIONAL GAMMA-RAY SPECTROMETER. R. W. Perkins (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Bioassay measurements of urine samples from residents of Richland, Washington, by multidimensional gamma ray spectrometric counting techniques showed the presence of several of the reactor effluent water and fallout radionuclides. (auth)

29 (HW-81746(p.3.16-20)) URANIUM ORE DUST INHALATION STUDIES. T. M. Beasley (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Sensitive radiochemical techniques were developed for the determination of uranium and thorium in rat tissue following inhalation of uranium ore dust. Radiochemical yields from spiked samples showed good recoveries (>94%) for both uranium and thorium with excellent decontamination from other uranium daughters. Preliminary results from exposed rats indicated a significant retention of thorium versus uranium in the rat lungs. (auth)

30 (HW-81746(p.3.95-7)) MEASUREMENT OF URANIUM ORE PARTICLE INHALATION BY RADON DAUGHTER COUNTING. R. W. Perkins, H. E. Palmer, and B. O. Stuart (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Preliminary studies showed that the deposition of uranium ore dust in the respiratory system can be traced by whole-body counting of radon daughters that attach themselves to these particles. Measurements at a uranium crushing mill showed about 30% retention of inhaled particles with approximately equal amounts of activity in the head and chest region. (auth)

31 (HW-81746(p.5.29-35)) INSTRUMENTATION FOR TOXICITY STUDIES OF INHALED RADIONUCLIDES. N. S. Porter (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Specialized instrumentation was required to obtain physiological data during toxicity studies of inhaled radionuclides. Data taken during the inhalation experiments include tidal volume and respiration rates. These parameters are measured with a thermistor-controlled bridge that drives a chart recorder under properly calibrated conditions. Deposition to the respiration tract has to be measured indirectly. To provide accurate measurements, the instrumentation was developed to control the flow of inspired and expired aerosols through a sliding valve. (auth)

32 (HW-SA-3641) THE DIRECT MEASUREMENT OF RADIONUCLIDES IN BIOASSAY SAMPLES BY MULTIDIMENSIONAL GAMMA-RAY SPECTROMETRY. R. W. Perkins (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). [Sept. 23, 1964]. Contract AT(45-1)-1350. 17p. (CONF-727-2). Dep.(mn); $1.00(cy), 1(mm) OTS.

From 10th Annual Bioassay and Analytical Chemistry Meeting, Cincinnati, Oct. 1964.

The direct bioassay measurement of radionuclides in urine samples by newly developed multidimensional gamma-ray spectrometric techniques has proven to be an extremely sensitive method for estimating radionuclide body burdens. The interference from natural radioactive potassium is eliminated for most radionuclides which decay by emission of two or more gamma-rays in cascade. The method is far more sensitive than present whole-body counting methods for the determination of body burdens of many radionuclides. In addition, the urine bioassay removes the uncertainty as to whether the radionuclide is in the blood stream or the gastro-intestinal tract. The multidimensional analysis is also more sensitive than many procedures which require both chemical separation and instrumental analysis, yet it provides a complete spectrum and a coincidence spectrum of the gamma radiation leaving a sample. Through use of these techniques the movement of many radionuclides at their present level can be traced through the food chain to man and their uptake and excretion rates can be measured. Results are reported from measurements of ^{64}Cu, ^{24}Na, ^{76}As, ^{46}Sc, ^{65}Zn, ^{60}Co, ^{22}Na, ^{134}Cs, and ^{137}Cs in ashed urine samples. (C.H.)

33 (NYO-3039-1) THE EFFECTS OF TRITIUM OXIDE ON AQUATIC ORGANISMS. Final Report, June 1, 1962–July 31, 1964. Donald M. Skauen (Connecticut. Univ., Storrs). Oct. 12, 1964. Contract AT(30-1)-3039. 17p. Dep.(mn); $1.00(cy), 1(mn) OTS.

An environment of tritiated water did not have an observed toxic effect on the common guppy. Some fish lived as long as ten months in the tritiated water, and long-term effects due to the build up of tritium in the fish were not apparent. There were no genetic changes in the third generation of fish living in the tritiated water. It was apparent that the amount of tritium in the fish reached equilibrium with that in the surrounding water. About 90% of the tritium present in the fish was in the body water, and only 10% was actually incorporated in the body tissues. The

turnover of tritium in the fish may have been rapid. Fish living for the longest time in tritiated water had less tritium present than in some of the other experiments. In this instance, the amount of tritium in the water was lower due to loss by evaporation over the extended period of time. The toluene distillation technique was used for water removal from the tissues in guppies prior to liquid scintillation counting of T_2O in body water and fish tissue residues. (C.H.)

34 (PNE-236F) FOOD-CHAIN RELATIONSHIPS OF IODINE-131 IN NEVADA FOLLOWING THE SEDAN TEST OF JULY 1962. Frederick B. Turner and William E. Martin (California. Univ., Los Angeles. School of Medicine. Lab. of Nuclear Medicine and Radiation Biology). July 24, 1964. Project 62-83 of PROJECT SEDAN. 60p. Dep.; $3.00(cy), 1(mn) OTS.

Following the Sedan test of July 6, 1962, in Nevada, the applicability of mathematical models to food-chain transfers of iodine-131 in natural environments was examined. The amounts of radioiodine measured in the thyroids of jack rabbits collected at 5-day intervals between July 5 and August 5 were compared to levels predicted by models on the basis of estimated levels of radioiodine on vegetation as of July 6. Four areas, from 20 to 110 miles from ground zero, were studied between 5 and 30 days after the test. The basic model was deterministic, but a probabilistic model predicated on the same assumptions was also developed and tested. The performance of the models was good enough to encourage further work of this nature. Analyses of vegetation samples suggest that the distribution of radioiodine on vegetation after the test was lognormal, not normal. When distributions of radioiodine on vegetation are defined as lognormal, and frequency distributions of thyroid radioiodine in large synthetic populations are generated by the computer, these distributions are also lognormal. Whether such distributions reflect the situation in nature depends on the validity of the assumptions built into the model. We believe that the model assumptions are qualitatively sound, and that lognormal distributions of radioisotope concentrations in organs are probably characteristic of populations consuming vegetation contaminated by local fallout. This conclusion is supported both by measurements of radioiodine on vegetation at various times between July 11 and August 5, and by analyses of observed distributions of radioiodine in the thyroid of herbivores consuming this vegetation. The assumption of the Federal Radiation Council that the majority of individuals do not vary from the average by a factor greater than three, appears reasonable, both on the basis of actual observations and analyses of synthetic distributions of 1000 individuals. If measurements of radioiodine on sagebrush (Artemisia tridentata) in the vicinity of Currant, Nevada (110 miles from ground zero), were even close to levels of radioiodine on cattle forage (i.e., no more than 10 times higher), it is an unavoidable conclusion that had milk been produced in this area during July of 1962, it would have contained radioiodine (2000-3000 $\mu\mu c/l$) temporarily far in excess of the limit of Range II recommended by the Federal Radiation Council (100 $\mu\mu c/l$). Levels would have been higher in areas closer to ground zero. Fortunately, there is little dairying in this part of Nevada. (auth)

35 (TID-7696(p.120-39)) EXCRETION OF STRONTIUM-90 FOLLOWING ACCIDENTAL INHALATION. W. L. Fisher and R. F. G. Kellehar (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.).

In December, 1960 an employee accidentally inhaled dust containing strontium-90 and several other radionuclides. The incident did not result in a serious exposure; however, the intake was sufficient to permit a long-term observation of the strontium biological half-life. Analysis has shown the urinary excretion of strontium to be best described by a sum of exponential terms. The half-life of greatest importance in determining strontium-90 maximum permissible concentrations is, at least for this one person, 468 days as contrasted to 1.8×10^4 days recommended by the ICRP and others. Methods used in this study and the results obtained to date are discussed. (auth)

36 (TID-7696(p.166-80)) ELIMINATION AND DEPOSITION OF ENRICHED URANIUM FOLLOWING ACUTE ACCIDENTAL INHALATION. Jacob Sedlet and Jean J. Robinson (Argonne National Lab., Ill.).

Difficulties that arise in the interpretation of bioassay data, even for an element as thoroughly studied as uranium, when whole-body counting data are not available are discussed. From the health physics viewpoint, that is, considering only the radiological health of the individual, it is important to assess the intake and the dose even though the maximum permissible body burden was not exceeded. The question arises whether an individual should be removed from further exposure for a time to keep his total radiation dose within the accepted limits. A confident assessment of the body burden in a case such as this is not a simple task. (auth)

37 (JPRS-26692(p.25-32)) ON COMPARATIVE MOBILITY OF P^{32} AND Ca^{45} IN A PLANT. G. V. Barinov. Translated from Izv. Sibirsk, Otd. Akad. Nauk SSSR, No. 4, Ser. Biol.-Med. Nauk, No. 1, 1963.

The relative mobility of ^{32}P and ^{45}Ca was determined in a plant by applying doubly tagged calcium phosphate to tomato leaves. The correspondence in values of ^{32}P and ^{45}Ca efflux was discovered. The hypothesis is stated that immobile elements are lacking under optimum conditions of plant growth. (auth)

38 CONTINUOUS MEASUREMENT OF $C^{14}O_2$ RESPIRED BY INSECTS. AN IONIZATION CHAMBER METHOD. J. R. Robinson and W. Chefurka (Dept. of Agriculture, London, Ont.). Anal. Biochem., 9: 197-203(Oct. 1964).

Details of a method and apparatus for continuous assay and recording of $^{14}CO_2$ respired by insects treated with ^{14}C-labeled materials are described. The technique, based upon an ionization flow chamber and vibrating reed electrometer, is sensitive to less than 10^{-8} μC of ^{14}C as $^{14}CO_2$ in the system and allows very economical use of labeled materials in the study of normal and poisoned metabolic pathways in vivo. (auth)

39 URINARY ELIMINATION OF RADIOACTIVE SUBSTANCES AFTER INJECTION OF IODINE-131-LABELED HAPTOGLOBIN IN MAN. Jacques Paul Borel, Jean Moretti, and Max F. Jayle (Faculte de Medicine, Paris). Bull. Soc. Chim. Biol., 46: 549-54(1964). (In French)

The urinary elimination of radioactive substances was studied in three patients given an injection of haptoglobin labeled with ^{131}I. After elimination of radioactive iodides by paper electrophoresis, several radioactive substances were separated and characterized by paper chromatography in different solvent phase systems. One of them is identical with control diiodotyrosine; its extraction from urine modifies some of its chromatographic properties. The other radioactive substances are probably phenolic acids resulting from the catabolism of diiodotyrosine. (auth)

40 STUDIES ON INHIBITION OF INTESTINAL ABSORPTION OF RADIOACTIVE STRONTIUM. T. M. Paul, Deirdre Waldron Edward, and Stanley C. Skoryna. Can. Med. Assoc. J., 91: 553-7(Sept. 5, 1964).

A method is reported that enables selective suppression of absorption of radioactive strontium from ingested food material, permitting calcium to remain available to the body. Studies were carried out by measuring blood levels and bone uptake of ^{89}Sr and ^{45}Ca at different time intervals after orogastric intubation of rats. The addition of sodium alginate, derived from brown marine algae, to the radioactive isotopes increased the overall physiological discrimination against strontium by amounts up to 60% after 24 hours. This discrimination was further increased by feeding sodium alginate mixed with standard diet in the proportions of 20:80 and 30:70. The observed ratio was reduced by administration of sodium alginate from 0.25 to 0.09. Determination of the limiting dosage in rats is restricted to the amounts which rats will consume. In the event of an inadvertent release of radioactive strontium, human sub-

jects probably could increase their intake of alginate at will, permitting a greater effectiveness of sodium alginate than could be obtained in experimental animals. (auth)

41 RELATIONSHIPS OF STRONTIUM–CALCIUM ACCUMULATION WITHIN CORN. G. W. Gorsline, W. I. Thomas, D. E. Baker, and J. L. Ragland (Pennsylvania State Univ., University Park). Crop Sci., 4: 154-6(1964). (TID-19796)

The range of Sr and Ca accumulation found in the relatively restricted samples of corn germplasm indicates that studies characterizing species on the basis of samples from one or two varieties or biotypes may result in misleading conclusions relative to species element accumulation tendencies. It is also suggested that plant breeding efforts probably would be successful in changing Sr and Ca contents of corn selections if this were deemed desirable. Ear leaf tissue from a 12-line 200 to 300 maturity corn all possible single cross set with inbred parents grown at one location and from a 9-line 700 to 900 maturity all possible single cross set grown at two locations in 1960 were analyzed spectrochemically for Sr, Ca, and nine other elements. It was concluded that, between genotypes of corn: both Ca and Sr accumulation levels were controlled largely by genes acting in an additive manner; locations and lines × locations interaction were important for both Sr and Ca; the correlation of Sr with Ca was very high and consistent; a given array of genotypes had similar relationships between Ca and Sr to other elements as environment and/or soil changed within the limits of this investigation, with the probable exception of Mg; and as genotypes and locations were changed, the relationship of accumulation levels of Ca and Sr, to levels of P, K, Fe, B, and Zn also changed. The ratio of Sr to Ca was also discussed. (auth)

42 A RADIOAUTOGRAPHIC STUDY OF CHROMOSOMAL REPRODUCTION IN VICIA FABA. A. B. Iordanskii (Inst. of Radiation, Physics, and Chemical Biology, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 158: 192-5(Sept. 1, 1964). (In Russian)

The reproduction of chromosomes was followed by obtaining quantitative data on the distribution of thymidine–^{3}H between chromatids, and also on the content of thymidine–^{3}H in the chromatids in a series of successive cell divisions. The bean shoots were grown 8 hours at 20°C in a solution of thymidine–^{3}H having a concentration of 2 μC/ml (a specific activity of 30 curies/mmol). The ends of the shoots (1.5 mm) were macerated 20 hours at room temperature in snail goiter juice, and suspended in 45% acetic acid. The single-cell suspension was mounted on a slide glass and dried. After drying the sample was covered with a liquid film emulsion, and exposed at 4°C for 24 days over anhydrous $CaCl_2$. A total of 7 fixations were carried out 6, 12, 23, 36, 40, 60, and 90 hours after introducing the tracer material. The 1st, 3rd, and 5th fixations correspond to divisions I, II, and III. The data show that in the division I the tracer content is the same in both chromatids. In division II, all the chromosomes are tagged, but each chromosome contains tracer only in one of the chromatids. In division III, both tagged and untagged chromosomes are encountered with the tagged chromosomes containing tracer material only in one chromatid. The number of silver grains per chromatid was calculated. (TTT)

43 EFFECT OF TEMPERATURE, pH AND TIME OF INCUBATION ON THE RADIOIODINE METABOLISM OF WHOLE RAT THYROID LOBES INCUBATED IN VITRO. Shin-ichi Shimoda and Monte A. Greer (Univ. of Oregon, Portland). Endocrinology, 75: 698-705(Nov. 1964).

The rate of thyroidal uptake and organic binding of ^{131}I was greatly depressed by incubation of rat thyroid lobes at 1°C but was only slightly lower at 24°C than at 37°C. Even at 1°C both MIT and DIT were formed within 30 min. Optimal pH for radioiodine accumulation and organic binding was approximately 7.4. Maximal intrathyroidal inorganic iodide accumulation when organic binding was permitted was at pH 5.5; iodide concentration fell progressively with increasing pH. After 6 hr of incubation at pH 7.4 the ability of the thyroid lobes to accumulate and bind radioiodine was rapidly lost. When radioiodine was present in the medium from the beginning of incubation, iodothyronines were first detectable at 6 hr and were maximal at 24 hr. Loss of organic radioiodinated material into the medium from the thyroid lobes was not apparent until 9 hr, and then increased progressively with time. Labeled MIT and DIT appeared in the medium only as peptide-bound substances; no iodothyronines were detectable in the medium up to 24 hr. (auth)

44 METABOLISM OF ^{125}I IN THE THYROID GLAND STUDIED WITH ELECTRON MICROSCOPIC AUTORADIOGRAPHY. O. Stein and J. Gross (Hebrew Univ., Jerusalem). Endocrinology, 75: 787-98(Nov. 1964).

Mice were injected with $Na^{125}I$, and autoradiographs of the thyroid were prepared for examination under the electron microscope. Iodination of thyroglobulin was not demonstrable within the cell. Under conditions of reduced turnover of thyroglobulin, the autoradiographic reaction occurred at the colloid cell boundary overlying the microvilli of the cell. In normal or stimulated thyroids the autoradiographic reaction was evenly distributed over the colloid at the earliest time intervals after injection (15 min). At later time intervals radioactivity could be localized over intracellular droplets; this was particularly apparent after TSH stimulation. It appeared that these droplets were formed at the apical cell membrane, and they were found throughout the cell. Some of those close to the capillary pole appeared shrunken, others in this location showed partial disintegration of their membranes. From this pattern it is postulated that iodination of thyroglobulin, occurs in the colloid in association with the microvilli. The intracellular droplets participate in the resorption of thyroglobulin and the release of thyroid hormone into the circulation. Since this is also associated with the release of iodotyrosines from thyroglobulin and their deiodination, it is suggested that the latter processes might take place in these droplets. (auth)

45 THYROIDAL TRANSPORT OF LARGE DOSES OF IODIDE IN IODINE-DEFICIENT RATS. J. R. Scranton and N. S. Halmi (State Univ. of Iowa, Iowa City). Endocrinology, 75: 803-4(Nov. 1964).

The thyroidal I^- transport mechanisms of rats kept on a low iodine diet showed saturation at serum I^- levels of 4×10^{-4}M or more, the maximal concentration of transported thyroidal I^- being $8 - 9 \times 10^{-3}$M. The results agree well with the equation of Wollman and Scow describing saturation of thyroidal I^- transport by its substrate. (auth)

46 COLLOQUIUM ON EVALUATION OF BODY BURDEN OF RADIOISOTOPES IN MAN, HELD IN HEIDELBERG BETWEEN 11 AND 16 MAY, 1964. Eduardo Ramos Rodriguez (Junta de Energia Nuclear, Madrid). Energia Nucl. (Madrid), 8: Suppl. A, No. 30, 3-9(Apr.-June 1964). (In Spanish)

Abstracts are given of the most important papers presented at the Colloquium on Evaluation of Body Burden of Radioisotopes in Man. The subjects discussed at the 16 sessions of the Colloquium were determination of radioactivity in the body, biological tests, interpretation of data, and cesium, radium, radon, strontium, tritium, thorium, uranium, and plutonium uptake. (J.S.R.)

47 DETERMINATION OF THE RATE OF DISAPPEARANCE OF ^{210}Pb FROM VARIOUS TISSUES OF THE RAT. Folia Med. (Naples), 47: 238-48(Mar. 1964). (In Italian)

The biologic disappearance rate of ^{210}Pb was studied in the rat after a single intravenous injection of Pb acetate, in doses of 100 μg of Pb per animal. The distribution curves of Pb in the different organs and tissues could be expressed by a set of exponential functions; ^{210}Pb removal occurs according to different phases. In the blood (plasma and cells) and in some of the other tissues examined there are two initial phases of rapid elimination and a final slow phase. In the liver and kidney, only one rapid phase and a slow phase were seen. On the other hand, the removal of the metal from the bone occurs at a constant, extremely slow rate. An interpretation of the results suggests the

presence of a complex form of Pb metabolism; the rapid phases may correspond to the elimination of lead as an ion either present in the intercellular spaces or weakly bound to the cells, while the slow phase probably expresses the elimination of lead bound to an organic compound. (BBB)

48 INCORPORATION OF ^{18}O FROM AIR INTO TYROSINE. Kikuko Takashima, Daisaburo Fujimoto, and Nobuo Tamiya (Tokyo Medical and Dental Univ.). J. Biochem. (Tokyo), 55: 122-5(Feb. 1964).

The incorporation of ^{18}O into the hydroxyl group of tyrosine by Pseudomonas aeruginosa, rat liver preparation, and silkworms was demonstrated. With both bacterial and mammalian systems, an appreciable amount of ^{18}O was incorporated into tyrosine from atmospheric oxygen, but the extent of incorporation was variable. In control experiments without the addition of phenylalanine, as a precursor, the amount of tyrosine formed after the incubation was negligibly small with P. aeruginosa, while in the case of the rat liver preparation, a considerable amount of tyrosine was detected. Therefore, in the latter case, a part of newly formed tyrosine must have been of endogenous origin. It is known that O atom in hydroxyl group of tyrosine is unexchangeable while the O atoms in carboxyl group are exchangeable in acidic medium; therefore, the ^{18}O atoms found in tyrosine preparations must be in the hydroxyl group. From the tyrosine-content of the reaction mixtures before and after the incubation and from the ^{18}O content of the tyrosine preparations, it was calculated that about 25% of O in the hydroxyl group of newly produced tyrosine is derived from atmospheric O in the case of P. aeruginosa, 60% of O in the hydroxyl group in the case of rat liver, and 8% incorporation of atmospheric O into silk-gland tyrosine of the silkworms. It was concluded that the O atom of the hydroxyl group of tyrosine is derived from air in the reaction catalyzed by phenylalanine 4-hydroxylase in bacterial, mammalian, and insect systems. The reason for the low value of incorporation in P. aeruginosa was not apparent. (BBB)

49 DISTRIBUTION OF ^{45}Ca DURING PREGNANCY UNDER CONDITIONS OF CALCIUM DEFICIENCY IN RATS. James W. Bawden and F. Thomas McIver (Univ. of North Carolina, Chapel Hill). J. Dental Res., 43: 563-7(July-Aug. 1964).

A study was undertaken to investigate placental function of rats in the Ca-deficient state by using an approach which would preclude the mobilization of previously fixed ^{45}Ca. On the 20th day of gestation, Sprague-Dawley rats were given 10 μC of ^{45}Ca orally, as $CaCl_2$, in a 0.5 ml volume of solution. In contrast to the previous study, the animals were sacrificed one hr after administration of ^{45}Ca to prevent mobilization of the isotope, which had entered the skeletons of the maternal animals, from contributing to the maternal-fetal distribution pattern of dietary ^{45}Ca. The results supported previous findings that the placenta is not capable of compensation in Ca deficiency. There was a close similarity of litter to femur ^{45}Ca distribution ratios in the experimental and control groups. Apparently, the only means by which the maternal animal may compensate for dietary Ca deficiency in providing adequate Ca to the litter are through increased retention of dietary Ca and increased net resorption of bone to maintain blood Ca levels. The data seem to indicate that maternal and fetal blood Ca levels tend to fluctuate in direct relation to one another. (BBB)

50 SUGARS AND UNCOUPLING AGENTS AS INHIBITORS OF CESIUM UPTAKE BY EXCISED WHEAT ROOTS. Kamel Saddik (Cairo Univ., Giza, Egypt) and Goran Stenlid. Lantbrukshogskol. Ann., 29: 241-6(1963).

The effects of 8 mono- and disaccharides on the uptake of ^{137}Cs (as 3×10^{-4}M CsCl) by wheat roots were studied. Of the sugars tested D-mannose and 2-deoxy-D-glucose distinctly inhibit the uptake of ^{137}Cs, whereas the others have only slight effects. The results agree in all essentials with those obtained in experiments on chloride absorption. It is stressed that galactose, which is a strong growth inhibitor, is noninhibitory with regard to both Cs and Cl uptake. Some experiments with combinations of two sugars were also performed. The inhibition caused by mannose or by 2-deoxy-D-glucose is reversed by glucose, sucrose, galactose, xylose, and fructose. The efficiency decreases in this order, glucose being the most active sugar. Pretreatment of the roots with aerated water for 24 hr greatly increased the capacity for absorption of Cs. In contrast to these results was the decrease in the absorption capacity for the metabolically important ions phosphate and nitrate under the same conditions. The uptake of ^{137}Cs was inhibited by concentrations stimulating chloride absorption, such as 2,4-dinitrophenol and salicylic acid. It was concluded that the absorption of the metabolically inert ions cesium and chloride differs not only with respect to specific interactions with their carriers but also in the reaction towards agents uncoupling oxidative phosphorylation. (TCO)

51 ABSORPTION OF CESIUM BY WHEAT AND PEA PLANTS AS AFFECTED BY SOME CATIONS. Kamel Saddik (Cairo Univ., Giza, Egypt). Lantbrukshogskol. Ann., 29: 247-57(1963).

The uptake of ^{137}Cs (as a 10^{-3} to 10^{-5}M solution of CsCl) by 9-day-old wheat and pea plants was investigated, as well as the influence of some cations, including Sr, on this process. Of the monovalent cations tested, K^+, Rb^+, Cs^+, and NH_4^+ retarded considerably the absorption of ^{137}Cs, whereas Na^+ and Li^+ did not interfere significantly. These results for both wheat and pea support earlier findings. It was also found that Ca^{2+} stimulates ^{137}Cs absorption by wheat and pea plants. During a two-hr experimental period, 1.7×10^{-3}M $CaCl_2$ increased the absorption of ^{137}Cs about 10% for wheat and nearly doubled the amount absorbed by the peas. $SrCl_2$ showed a similar effect to $CaCl_2$ and the stimulatory effect increased as the concentration of Cs^+ increased. Higher concentrations of $CaCl_2$ depressed the uptake of Cs^+. In pea roots Cs^+ uptake has about the same efficiency as K^+, whereas in wheat roots K^+ is distinctly more efficient. The results agree with those reported for excised barley roots. The interference between the ions is interpreted as competition at carrier sites in the root, and it seems that the same type of carrier system is working in barley, wheat, and pea roots. Na^+ and Li^+ do not depress the absorption of Cs^+ in the concentrations used. Nor does Na^+ depress the absorption of K^+, although K^+ inhibits the Na^+ uptake. It is suggested that K^+ (and also Cs^+) may be absorbed via more than one mechanism. (TCO)

52 THE RELATIONSHIP BETWEEN THE Sr-90/Ca URINE/FOOD RATIO AND URINARY CALCIUM OF HUMAN BEINGS. Wanda Czosnowska (Inst. of Occupational Medicine, Lodz, Poland). Nukleonika, 9: 757-8(1964).

Studies were made on the ^{90}Sr/g Ca excretion in human urine. Ten adult persons of both sexes were divided into two groups (5 in each) according to the dietary composition of food received. The daily dose of Ca averaged 1270 mg for the first group and 760 mg for the second. Average daily intake of ^{90}Sr during the study was 28.0 $\mu\mu$C and 16.4 $\mu\mu$C, respectively. The results indicated that the ^{90}Sr/g Ca urine-diet ratio for both groups averaged 0.75. The correlation between ^{90}Sr/g Ca urine/food ratio and urinary calcium found was −0.88 significant at the 0.01 level. The results seem to indicate that ^{90}Sr/g Ca ratio in food can be predicted reasonably well from ^{90}Sr/g Ca ratio in urine and urinary calcium. (P.C.H.)

53 EFFECT OF NATURAL EXTRACTS UPON THE SORPTION OF SOME RADIOISOTOPES BY THE SOIL. M. Ya. Volkova, G. I. Makhonina, and A. A. Titliyanova. Pochvovedenie, No. 3, 52-7(1964). (In Russian)

A study was carried out of the desorbing properties of some natural extracts (water extracts from yellow leaves of aspen, birch, bird cherry, ferns, and pine needles) in respect to following radioisotopes: ^{86}Rb, ^{90}Sr, ^{106}Ru, ^{110}Ag, ^{115}Cd, and ^{144}Ce. All the above elements increased their mobility under the influence of extracts. It is supposed that the desorbing effect of the extracts is connected with the formation of soluble complex compounds of the above metals with organic substances; the desorption effect of

extracts on Rb and Sr depends upon the cations present in the extracts. (auth)

54 BEHAVIOR OF RADIUM AND CALCIUM IN THE SOIL-PLANT SYSTEM. G. V. Rusanova. Pochvovedenie, No. 3, 53-70(1964). (In Russian)

A study was carried out on strongly podzolic humus-ferroginous, soddy-podzolic, and humose-gleyed soils contaminated with radium. A correlation was found between the radium and calcium contents in soil genetic horizons. Accumulation of radium by Ranunculus acer, Taraxacum officinale Webb, Trifolium pratense L., and Deschampsia caespitosa L. depends upon radium mobility in soils. Nearly all radium in the aerial part of the plants is available. (auth)

55 COMPARATIVE STUDIES ON ABSORPTION OF RADIOACTIVE STRONTIUM AND CALCIUM FROM THE GASTROINTESTINAL TRACT. Stanley C. Skoryna, Joginder S. Makhani, Alexander C. Dukay, and Donald R. Webster (McGill Univ., Montreal). Surg. Forum, 13: 344-5(1962).

Differentiation between ^{89}Sr and ^{45}Ca and their fate in the organism are of considerable importance because of the chemical relation between the two isotopes and the resulting hazards of exposure. The ingestion of radiostrontium-containing nutrients appears to be the principal route of entry into the human body. It has been established that Ca is absorbed preferentially from the intestinal tract by a factor of about two. The present study was designed to determine the difference between the absorption rates of these isotopes in male rats. Radioactive Ca and Sr were injected into segments of the small bowel, 5 cm in length and ligated at both ends. The total length of the stomach, jejunum, and ileum was divided into 10 segments. One segment was studied in each experimental group. A dose of 20 μC of the isotope (in 0.5 ml distilled water) was injected into each loop. Absorption was thus determined in all 10 segments. With standard Geiger-Müller counting techniques the rate of disappearance of the isotope from the intestinal segments was measured at intervals until the absorption was complete. The results showed that the maximal absorption of ^{89}Sr occurred in the segments III to X while that of ^{45}Ca was definitely localized in the duodenal segment. Comparison of the rates of absorption of the two isotopes showed a marked difference in favor of Ca. In the first hour, 40 to 62% of ^{89}Sr was absorbed from the segments III to X; this increased gradually until 87 to 94% absorption occurred in 12 hr. Eighty-seven % of ^{45}Ca was absorbed in the first hour from the duodenum and almost complete absorption (97%) occurred in 2 hr. It is concluded that maximal absorption of Ca occurs in the duodenum, while that of Sr takes place in the jejunal segments. It is possible that Sr requires a longer period of time to enter into a state in which it can be absorbed. The discriminatory mechanism in favor of Ca absorption may be based upon the rate of absorption in relation to time of passage of intestinal contents. The faster rate of absorption of Ca would then constitute the protective factor in exposure to radiostrontium. (BBB)

56 POTASSIUM-40 MEASUREMENTS OF BODY COMPOSITION. John E. Christian, Loyal W. Combs, and Wayne V. Kessler (Purdue Univ., Lafayette, Ind.). Postgrad. Med., 36: 156-63(Aug. 1964).

The application of a new approach for rapid, convenient in vivo determination of the lean body mass (LBM) and fat content of human subjects, as an estimate of gross body composition, is described. This technic was applied to evaluate the effect of an anorectic agent and weight loss on the body composition of normal clinically obese human subjects on a weight-reducing regimen. The anorectic agent used was dextroamphetamine sulfate in the form of 15-mg sustained-release capsules. The body weight, body K, LBM, and fat of each individual were determined prior to initiating the drug and diet regimen, periodically during the experiment, and following its termination. Total body K content was determined using a 4-pi large-volume liquid scintillation counter, the construction of which is described and illustrated. The detector assembly is enclosed within a steel room which is used as a shield against cosmic radiation. Total body K was calculated from ^{40}K γ activity emanating from each subject as averaged from four one-minute counts and corrected for background (average of two one-minute counts before and two one-minute counts after the determination for each subject). In addition, corrections were made for background depression, variation in efficiency, and efficiency of the detector The LBM and the fat content were calculated from the total body potassium. The ^{40}K measurements revealed a ±1.4% change in the K values as statistically significant. Comparison of average pretherapy K levels with the average levels found at three-week, eight-week, and post-therapy intervals clearly indicated no decrease in body K. Since K levels are related to LBM, these findings indicate no loss in the LBM. Accordingly, total weight loss in the subjects studied was attributed to the loss of excess body fat. The 1200-calorie diet used was calculated to provide a daily deficit of 1200 calories, which is equivalent to ~0.30 lb of fat. On this basis, the 12-week program would result in an average loss of 25.2 lb of body fat, which was in close agreement with the actual average loss (25.4 lb). This also confirms the findings that only body fat was lost from the subjects tested. This study illustrates how the recent development of whole-body liquid scintillation counters for the in vivo nondestructive measurement of low levels of γ-emitting radionuclides in large animals and man has opened new opportunities for studying body composition and changes in body composition resulting from such factors as differences in nutrition, physical fitness, drug therapy, and disease. Changes in body composition can be evaluated by serial measurements on the same individual over the period of an experiment. (BBB)

57 EFFECT OF HIGH PHOSPHORUS INTAKE ON Sr^{85} EXCRETIONS IN MAN. Herta Spencer, Jacob Menczel, and Joseph Samachson (Veterans Administration Hospital, Hines, Ill.). Proc. Soc. Exptl. Biol. Med., 117: 59-63(Oct. 1964).

The effect of high phosphorus intake on radiostrontium absorption was investigated in 6 patients. Two of these were studied during low calcium diet, 2 during high calcium intake, and 2 patients during low and high calcium intake. Addition of phosphorus to the diet led to a decrease in ^{85}Sr absorption in 3 of the 4 patients each studied during low and high calcium intake, respectively. Urinary ^{85}Sr excretion and urinary calcium excretion were decreased during high phosphorus intake in both the low and high calcium studies. (auth)

58 SOME FACTORS INFLUENCING INTERPRETATION OF STUDIES OF BODY WATER AND ELECTROLYTES WITH ISOTOPIC TRACERS. Sam A. Threefoot (Tulane Univ., New Orleans). Progr. Cardiovascular Diseases, 5: 32-54(July 1962).

A review is given on the physical, chemical, and biologic factors that influence determination by radioisotopes of volume of distribution of body water and electrolytes and calculated exchanging electrolyte mass, and some values obtained with particular reference to biologic influences on estimation of these parameters are presented. It is unlikely that there are any significant irradiation effects on the organism from the quantities of isotopes used in tracer studies of body water and electrolytes. It is conceivable, however, that with some tracers distributed in relatively heavy concentration to specific organs and with long effective half-lives, such as isotopes of Ca or Sr in bone, there may be some effect on the organ. There are physical influences on the organism from isotopes with relatively great differences in atomic weight, as when ^{2}H is used to trace ^{1}H. The influence of carrier substances on turnover and distribution of tracer in the organism and on physiologic processes is discussed. The use of substitute tracers is also considered. The most widely used substitutes are ^{82}Br ($t_{\frac{1}{2}}$ 35.8 hr) for tracing Cl, and ^{86}Rb ($t_{\frac{1}{2}}$ 18.6 days) for tracing K. Mathematical calculations of turnover rates of isotopes as indicative of behavior of tracer electrolyte are provided. Some values for exchangeable mass of water and

electrolytes obtained with various isotopes are presented. The use of the following tracers in such studies is discussed: $^{2}H_2O$, $^{3}H_2O$, $^{14}CO_2$, ^{14}C-sucrose, ^{22}Na, ^{24}Na, ^{28}Mg, ^{36}Cl, ^{38}Cl, ^{40}K, ^{42}K, ^{45}Ca, ^{82}Br, ^{86}Rb, ^{134}Cs, and ^{137}Cs. (TCO)

59 ACCUMULATION AND RETENTION OF CESIUM^{137} BY MARINE FISHES. John P. Baptist and Thomas J. Price (Bureau of Commercial Fisheries, Washington, D. C.). U. S. Fish Wildlife Ser., Fishery Bull., 206: 177-87(1961).

A series of laboratory experiments were performed in which accumulation and retention of ^{137}Cs by marine fishes were followed. In order to simulate conditions occurring in a marine environment which might control the availability of the radionuclide, ^{137}Cs was administered orally to fish in some experiments while in others the fish were kept in sea water containing known amounts of the radionuclide. Postlarval summer flounder (Paralichthys dentatus) concentrated 9 to 11 times the amount of ^{137}Cs in sea water during a period of 91 days. The rate of accumulation per unit weight decreased during periods in which the flounder gained weight rapidly. On the other hand, when the flounder did not significantly gain weight, the rate of accumulation increased. This was attributed to the disparity between rate of accumulation and rate of weight increase. Atlantic croaker (Micropogon undulatus) concentrated ^{137}Cs in heart, liver, and spleen by a factor of 9 times the amount in sea water after 29 days. Muscle accumulated the radionuclide at a slower but more uniform rate with a concentration factor of 4.5. Orally administered ^{137}Cs was rapidly absorbed from the digestive tract of croaker with only 10.8 percent of the dose remaining after 24 hours. Maximum concentrations of ^{137}Cs occurred in all tissues of croaker, except muscle, within 24 hours following oral administration. Tissue distribution of ^{137}Cs was similar in croaker (Micropogon undulatus), bluefish (Pomatomus saltatrix), and little tuna (Euthynnus alleteratus) 24 hours following oral administration, with highest tissue concentrations in the following order: heart, liver, spleen, kidney, gills, gonad, muscle, skin and scales, blood, and bone. Whole-body retention of ^{137}Cs by postlarval flounder was expressed as two rate functions with biological half-lives ($t_{\frac{1}{2}}$'s) of 5.3 and 36.9 days representing 34 and 66 percent of the ^{137}Cs at zero time. Composite ^{137}Cs retention curves of croaker tissue were resolved into multiple rate functions. (auth)

60 THE PHOSPHATATIC CATALYTIC EFFECT OF THORIUM AND ZIRCONIUM IONS ON NUCLEOTIDES AND COENZYMES. Heinz Trapmann and Muljibhai Devani (Universität, Munich). Z. Physiol. Chem., 328: 207-11 (1962). (In German)

The phosphatatic effect of metal ions of subgroup 4 of the periodic system in both alkaline and acid pH ranges is a nonspecific effect which could produce metabolic disturbances. Under physiological conditions mononucleotides are dephosphorylated by these metal ions, and phosphoric acid can be removed from coenzymes, such as cocarboxylase, riboflavin phosphate, and pyridoxal phosphate. At 37° and at a pH of 7 in the presence of Th ions, 32% of the phosphate was removed from adenosine-3′-phosphate after 6 hr, but only 3% of adenosine-5′-phosphate was dephosphorylated after 24 hr treatment. The 2′ isomer of adenylic acid is dephosphorylated much faster than the 3′ isomer in the presence of Th ions. The effect of Th ion here is similar to that of Ce and La ions. Both Th and Zr catalyze the dephosphorylation of adenosine triphosphate, but Th ions are more than twice as effective as Zr ions. Removal of phosphate from thiamin pyrophosphate is much more rapid than from riboflavin or pyridoxal phosphates. In thiamin phosphate, not only the terminal phosphate residue is removed, but also the intermediately located thiamin phosphate is subject to the effect of Th and Zr, although the effects of Zr are somewhat less. At pH 6, in presence of Th ions, 25% of the total phosphate is split off within 1 hr, and 33% is split off at pH 8. With Zr ions, 16% of the phosphate is split off at pH 6 to 7, and 25% is lost at pH 8. Both Th and Zr are much less effective in removal of phosphate from riboflavin; only 10% of the phosphate is removed after 4 days reaction. Effects on pyridoxal phosphate amount to only 3% dephosphorylation after a reaction period of 6 days with Th ions. Zr ions have no perceptible effect on pyridoxal phosphate. (BBB)

61 METHODS FOR THE ANALYSIS OF INTERNAL CONTAMINATION WITH RADIOACTIVE MATERIAL BY REPEATED EXAMINATION OF THE ACTIVITY OF THE BLOOD. Vlastimil Slouka (V.L.V.D.U., Hradec Kralove, Czech.). Vojenske. Zdravot. Listy, 30: 127-30(1961). (In Czech)

As a screening test for internal contamination is sufficient one sample of blood obtained during the first 2 to 3 days following the contamination, a quantitative determination is possible from at least three samples collected up to the fifth to seventh day after the contamination. The estimation of the physical half-life of the contaminating substance and the recognition whether the contamination was caused by one or by several radioactive substances can be accomplished by measurement of more samples. The equation for the decrease of activity in the blood is mostly the sum of several exponential functions. (auth)

62 REACTIONS IN THE GAS PHASE BETWEEN THERMAL ENERGY ELECTRONS AND COMPOUNDS OF BIOCHEMICAL INTEREST. J. E. Lovelock (Baylor Univ., Houston, Tex.). p.183-95 of "Physical Processes in Radiation Biology." New York, Academic Press, 1964.

A technique is discussed by which the reaction between free electrons and molecules in the gas phase could be observed. Emphasis is placed on physical basis, scope, and limitations of the method. The factors affecting the reactivity of different molecular species to free electrons are considered, and the relevance of the observations to the function of the free electron in the living cell is pointed out. (H.M.G.)

63 MINERAL METABOLISM. AN ADVANCED TREATISE. VOLUME II. THE ELEMENTS. PART A. C. L. Comar and Felix Bronner, eds. New York, Academic Press, 1964. 658p.

Topics included are: chemical composition of the body; dynamics and function of phosphorus; disturbances of phosphorus metabolism; dynamics and function of calcium; disturbances of calcium metabolism; magnesium; strontium; and fluoride. Separate abstracts were prepared for the discussions of: dynamics and function of calcium; disturbances of calcium metabolism; and strontium. (H.M.G.)

For abstracts of individual chapters see: 64, 65, and 66.

64 DYNAMICS AND FUNCTION OF CALCIUM. Felix Bronner (Cornell Univ., Ithaca, N. Y.). p.341-444 of "Mineral Metabolism. An Advanced Treatise. Vol. II." New York, Academic Press, 1964.

Major pathways and reservoirs of Ca in the body and factors affecting its behavior in soft and hard tissues are considered, with the aim of laying the basis for a systems analysis of Ca metabolism and its regulation. The following categories are discussed: calcium analysis; calcium isotopes; calcium as an essential nutrient; calcium in blood and body fluids; relation to excitable and contractile tissues; calcium in subcellular particles; calcium in bone; systems analysis; and nutritional considerations. (H.M.G.)

65 DISTURBANCES OF CALCIUM METABOLISM. William C. Thomas, Jr. (Univ. of Florida, Gainesville) and John Eager Howard. p.445-482 of "Mineral Metabolism. An Advanced Treatise. Vol.II." New York, Academic Press, 1964.

A résumé of biochemical, biophysical, and anatomical features of calcium metabolism includes: role of the skeleton, state of calcium in body fluids, and calcium homeostatis. Specific disorders discussed are: calcium deficiency with normocalcemia; hypocalcemic states; and the relation between calcium metabolism and the adrenal corticoids. (H.M.G.)

66 STRONTIUM. C. L. Comar and R. H. Wasserman (Cornell Univ., Ithaca, N. Y.). p.523-72 of "Mineral

Metabolism. An Advanced Treatise. Vol. II." New York, Academic Press, 1964.

A general overview of the development of the present understanding of Sr metabolism is presented in terms of the comparative movement of Sr and Ca. Specific areas discussed include: gastrointestinal absorption and excretion; renal excretion; bone and fetal deposition; secretion into milk and eggs; and Sr and Ca in the food chain and man. (H.M.G.)

Radiation Effects

Refer also to abstract 860.

67 (AAEC/TM-263) SOME EFFECTS OF GAMMA RADIATION ON PHASEOLUS VULGARIS SEEDS. Pamela A. Wills (Australia. Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). Aug. 1964. 27p. Dep.(mn).

Beans of the Phaseolus vulgaris variety may be treated with gamma radiation to destroy their viability. From the results of laboratory germination tests it would appear that the requirements of the Australian quarantine regulations for imported beans would be met by radiation doses of 40,000 rads for brown beauty, red kidney, and Michigan pea beans, 50,000 rads for borlotti and baby lima beans, 75,000 rads for butter beans, and 80,000 rads for black-eye beans. Baby lima beans which had received an irradiation dose of 1×10^6 rads were examined for changes in moisture, ether soluble, total nitrogen, ash, thiamine, riboflavin, and free sulphydryl and disulphide content. (auth)

68 (AD-600960) CHRONIC WHOLE-BODY GAMMA RADIATION STRESS IN THE ALBINO RAT AND MOUSE. Annual Progress Report, March 1963–June 1964. Sidney O. Brown (Texas. Agricultural and Mechanical Coll., College Station. Engineering Experiment Station. Radiation Biology Lab. and Texas. Agricultural and Mechanical Coll., College Station. Research Foundation). 99p. $2.25 (OTS).

The recovery of the hematopoietic system following exposure of the whole animal to continuous and macrofractionated doses of gamma irradiation was studied in rats and mice. Following twelve weeks irradiation exposure, all animals were placed in the control environment and the recovery of the hematopoietic system evaluated. From this hematological data it is obvious that gamma irradiation at a ratio of 40 or 50 R per day for periods of twelve weeks, total doses of 4200 and 3360 R, does not do sufficient permanent damage to interfere with complete recovery of the peripheral blood picture. Exposure of 12 weeks dose rates in excess of 50 R per day would be necessary to produce sufficient damage to prevent recovery of the hematopoietic system. Results are included from a study of the effects of acute and chronic irradiation on sperm activity of rats. (87 references.) (C.H.)

69 (HW-81746(p.5.36-45)) PHYSIOLOGICAL DATA TELEMETRY. D. P. Brown, N. C. Hoitink, N. S. Porter, and J. Ryden (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

During biological studies of radiation effects on sheep, swine, and dogs, it is generally necessary to monitor physiological functions such as temperature, respiration rate, and cardiac activity. Provisions must be made for continuous monitoring during periods when subjects are ambulatory, under direct observation during experimentation or surgery, and in terminal status. The physiological data telemetry system is being developed to provide the required information. Miniature solid state circuitry is employed to reduce transducer and transmitter size and to minimize animal discomfort. Initial experimental effort utilized both amplitude and frequency modulated signals at a transmission frequency of about 46 kc/sec. Later experiments employed considerably higher frequencies to secure more miniaturized instrumentation. With the latter system approach, successful telemetry of body temperature was achieved using sheep. Progress was made in using transducers in the respiration rate and cardiac activity measurements. The experiments completed to date indicated that development of the system will be completed in 1964. (auth)

70 (IAEA-R-18) THE EFFECTS OF IONIZING RADIATION ON SINGLE-STRANDED DEOXYRIBONUCLEIC ACID FROM THE BACTERIOPHAGE ϕX174. [PART] I. Joh. Blok, R. H. Dekker, and G. M. van der Ent (Leiden. Universiteit). Sept. 1962. Contracts IAEA $18R_2$ and 112. 22p. Dep.(mn).

Results are reported from a study of the effects of x radiation on deoxyribonucleic acid from bacteriophage ϕX174. The topics discussed include the irradiation method used, the measurement of dose, the determination of the radiosensitivity of the bacteriophage suspended in concentrated broth (direct effect), and the radiosensitivity of the capacity of the bacterium E. coli C to reproduce ϕX174. (auth)

71 (LF-17) RESPONSE TO SECONDARY ANTIGENIC STIMULUS AFTER WHOLE BODY X IRRADIATION IN THE BEAGLE. F. F. Pindak, J. F. Stara, and W. E. Clapper (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Sept. 1964. Contract AT(29-2)-1013. 14p. Dep.; $1.00(cy), 1(mn) OTS.

The results of the administration to healthy beagles of a secondary antigenic stimulus (booster dose) of Leptospira canicola and infectious canine hepatitis virus (ICH) are reported. Twelve previously vaccinated animals were used. Six were exposed to a 335 R dose of x irradiation. Three controls and three irradiated dogs received the booster dose two days after the irradiation and the remaining six, seven days after. Agglutinin titres for Leptospira canicola of 1:32 to 1:256 were observed in the 12 beagles before the booster dose. No increases of significance were found in either the controls or the experimental group after the booster dose. Complement fixing titres for the ICH virus of 1:16 to 1:64 were seen in all animals before revaccination. There was no significant difference in the titres of the control group and the experimental group which were given the ICH booster seven days after irradiation. However, the response observed in the controls given the booster after two days was absent in the irradiated animals. (auth)

72 (NP-14375) A STUDY OF MEAT ENZYMES TO DETERMINE MEANS FOR THEIR CONTROL. Annual Report No. 4, January 3, 1962–January 2, 1963. W. A. Landmann (American Meat Inst. Foundation, Chicago). Contract DA-19-129-QM-1952. 30p. (AD-601063). $0.75 (OTS).

Storage studies of irradiated ground meat showed that proteolysis could be most effectively inhibited by treatments which reduced the pH to less than 5 and by NaCl. (auth)

73 (NYO-2814-1) EFFECT OF X-RAYS ON THE MEAL WORM, TENEBRIO MOLITOR, EMBRYO. I. CHANGES IN THE PROTEIN AND FREE A-AMINO NITROGEN FRACTION. Terminal Summary, October 15, 1964. Donald S. Po-Chedley (D'Youville Coll., Buffalo). Contract AT(30-1)-2814. 7p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Data are reported on changes induced by x radiation in the content of amino acids in four-day-old meal worm embryos, Tenebric molitor; Asparagine, arginine, histidine, phenylalanine, serine, threonine, tryptophane, tyrosine, and valine increased in concentration while alanine, aspartic acid, cystine, glutamic acid, glutamine, glycine, methionine, and proline decreased in concentration with respect to normal values. These variations were restored to normal values in the surviving embryos during the post-irradiation period. It was concluded that radiation resistance of the meal worm embryo increases with its developmental progress. (C.H.)

74 (PDL-42277) BIBLIOGRAPHY ON MICROORGANISM CONTROL BY IONIZING RADIATION. (National Research Council. Prevention of Deterioration Center). Sept. 1960. 9p. (AD-601281). OTS.

Forty-eight references are presented to the literature on uses of ionizing radiation in the control of bacteria, fungi, other microörganisms, and insects. (C.H.)

75 (TID-21117) BIOCHEMICAL STUDIES ON IRRADIATED PROTOZOA. II. CATALASE ACTIVITY IN TETRAHYMENA PYRIFORMIS W. Jay S. Roth and Gayla Buccino (Connecticut. Univ., Storrs). [1963]. Contract AT(30-1)-2737. 30p. Dep.(mn); $2.00(cy), 1(mn) OTS.

The amount, distribution, and some properties of catalase activity in Tetrahymena pyriformis W were determined. The enzyme specific activity is about 10% that of rat liver and is found principally in a particulate fraction that may be sedimented at 200 x g. The enzyme is insensitive to pH changes but is destroyed by heating. The effect of catalase inhibitors on the growth, respiration, and enzyme activity of the protozoa was investigated. Allylisopropylacetamide, an inhibitor that is effective in preventing catalase synthesis in rats, renders the protozoa more sensitive to irradiation with 500,000 R of γ rays. (auth)

76 (UCRL-11387(Suppl.)(p.19-51)) INACTIVATION AND RECOVERY OF MICROORGANISMS AFTER TREATMENT WITH ULTRAVIOLET LIGHT OR OTHER MUTAGENS. Robert H. Haynes (California. Univ., Berkeley. Lawrence Radiation Lab.).

Macromolecular events that appear to cause death in bacteria exposed to ultraviolet light are reviewed. Topics discussed include photoinactivation, the concept of target macromolecules relevant to inactivation, DNA as a target relevant to cellular inactivation, DNA structural defects relevant to inactivation, and intracellular repair of DNA structural defects. Results are summarized from a series of studies on irradiated yeast and Escherichia coli. Results are compared with results of studies on the effects of other mutagens such as x radiation and nitrogen mustard in bacteria and yeast. (C.H.)

77 (JPRS-26532) STUDIES ON IONIZING RADIATION. Vera Nikolaevna Strel'tsova and Yu. I. Moskalev. Translation of parts of "Blastomogennoe Deystvie Ioniziruyushchey Radiatsii" (a publication by the "Meditsina" Publishing House, Moscow, 1964). 106p. (TT-64-41790). $4.00(OTS).

Possible mechanisms responsible for tumors of radiation etiology are discussed. The world literature on the subject is reviewed. It is concluded that radioinduced neoplasms may be considered as somatic mutations. The mechanisms involved in the appearance of these mutations may vary. The occurrence of most tumors, including those of the skeleton, skin, liver, kidneys, and stomach, result from direct radiation exposure and is probably linked with mutations caused by chromosome injury and with chemical mutations consisting in injury to the enzyme systems of the oxidative cycle. The mechanism involved in the development of tumors of the endocrine glands, and organs functually associated with them, is even more complex. (C.H.)

78 (JPRS-26692(p.9-17)) VARIATION IN FREQUENCY OF INJURIES TO CHROMOSOMES CAUSED BY RADIATION IN THE INITIAL RADICLE OF WHEAT PLANT. P. K. Shkvarnikov and A. M. Livensi. Translated from Izv. Sibirsk. Otd. Akad. Nauk SSSR, No. 4, Ser. Biol.-Med. Nauk, No. 1, 1963.

A study was made of the frequency of chromosome aberrations in the individual germinal radicles of each wheat seed irradiated with 15,000 R γ radiation. Statistically significant differences in frequency of the evoked chromosome aberrations in the separate germinal radicles of a single seed were ascertained in 97% of the seeds studied. These differences were attributed to differences in the physiological state of the cells from which the different germinal radicles develop in the course of the seed's sprouting. The dependence of the mutagenic effect of radiation on the differences which are already inherent in the different cells of a certain part of the dormant seed indicates the exceptionally great significance of the physiological state of irradiated tissues in obtaining any particular effect from irradiation or other action. (auth)

79 (JPRS-26960) THYROID GLAND IRRADIATION AND OTHER RADIOLOGICAL STUDIES. Translated from Med. Radiol., 9: No. 8, 16-18; 28-37; 45-51; 78-80 (Aug. 1964). 35p. (TT-64-51216). $2.00(OTS).

Separate abstracts were prepared for translations of four articles from the Russian-language periodical. Translations of other articles that are included discuss the functional state of the thyroid gland following irradiation with fast neutrons and the disruption of the permeability of skin capillaries as a result of the combined effect of ^{131}I and noise. (C.H.)

For abstracts of individual papers see: 80, 229, 230, and 231.

80 (JPRS-26960(p.20-8)) THE DISTRIBUTION OF P^{32} IN THE ORGANS OF ANIMALS IN CASES OF ACUTE RADIATION SICKNESS AND ITS COMBINATION WITH BLOOD LOSS. A. F. Karchevskii. Translated from Med. Radiol., 9: No. 8, 45-51(Aug. 1964).

Phosphorus-32 permeability was used as the criteria of the effects of whole-body irradiation alone, or combined with acute blood loss (25% of the total blood), on recovery of rabbits from radiation sickness induced by exposure to 1400 R whole-body γ radiation. Determinations were made periodically of hemoglobin, erythrocytes, and leukocytes in the experimental animals, and the ^{32}P content of liver, kidneys, spleen, adrenal glands, muscle, brain, eye moisture, and whole blood was determined in animals killed from 2 to 24 hr after irradiation. Analysis of the data led to the conclusion that the decrease in blood content of ^{32}P noted in irradiated animals and those subjected to a blood loss was caused by an increase in the permeability of the vascular system with regard to ^{32}P. As acute radiation sickness developed, the accumulation of ^{32}P in the tissues of the liver, kidneys, adrenal glands, and spleen decreased. It was concluded that an early loss of blood in irradiated animals has a certain normalizing effect on the permeability of the vascular-tissue barriers with respect to ^{32}P, and also increases the stability of the irradiated tissues, as expressed in an inhibition of the sorption properties of certain tissues with respect to ^{32}P. (C.H.)

81 RADIATION RESISTANCE OF ENTEROCOCCI DRIED IN AIR. Ebbe Ahrensburg Christensen (Statens Seruminstitut, Copenhagen). Acta Pathol. Microbiol. Scand., 61: 483-6(1964).

The radiation resistance of a total of 38 strains of enterococci was determined by means of gamma and electron irradiation. Twenty-four strains belonging to Streptococcus faecium were more resistant than the remaining 14 strains belonging to Streptococcus faecalis and Streptococcus durans. Irradiated with doses in common use for radiation sterilization, at least three of the faecium strains examined in the dry state were more resistant than subtilis and pumilus spores examined by the same technique. (auth)

82 LIVER REGENERATION IN WHOLE-BODY IRRADIATED RATS. Antero Voutilainen (Univ. of Helsinki). Acta Pathol. Microbiol. Scand., 61: 521-9(1964).

Attempts were made to determine whether small radiation doses given in the resting phase of hepatic cells before the initiation of regeneration cause fluctuations in the mitotic indexes, and whether there are more or fewer pathologic mitoses when the irradiation is given earlier or immediately before regeneration. Three-month-old male rats were distributed into groups of 10 animals. Whole-body x irradiation, 250 R, was given to two groups and 70% hepatectomy was performed 7 days later on one group and one control group. The rats were decapitated two or 14 days later and the liver mitoses were counted in an area of 0.785 mm^2. The weight indexes of liver at the time of decapitation were recorded. In a second experiment irradiation was given immediately before hepatectomy but otherwise the procedure was as described above. In the nonhepatectomized rats given irradiation the mitoses remained throughout at the level of the controls, but in both groups treated with irradiation plus hepatectomy mitoses were more numerous two days after hepatectomy than in the nonirradiated hepatectomized group. Within two days

pathological mitoses accounted for nearly one half of all of the mitoses in the irradiated hepatectomized group. The weight index rose significantly in the irradiated non-hepatectomized group when irradiation had been administered 7 + 2 days earlier. Macronuclear cells and swelling of cells were observed in the irradiated liver in consequence of the mitotic disturbances. It is probable that irradiation to cells before the start of regeneration causes not only an increase in abnormal mitoses but also an abnormal incidence of mitoses in the initial phase of regeneration since the cell division time has been prolonged. (BBB)

83 SUBRADIATION EXPERIMENTS CONCERNING THE CONCEPT OF THE NATURAL RADIATION ENVIRONMENT. James G. Eugster (Universität, Bern). Aerospace Med., 35: 524-6(June 1964).

Results are reported of radiobiologic experiments conducted at an ultralow background site, the Simplon tunnel in Switzerland, which provides complete rock shielding so that the instrument background of ionization chambers can be measured. An experimental facility is situated nearly in the middle of the tunnel. In order to provide an arrangement for radon-free ventilation, air is compressed and stored in cylinders for more than a month. Investigations conducted in this observation station served several purposes. First, they provide information as to the possibility that cosmic rays could still be measurable at this depth (7700 ft underground). Second, the instrument background can be measured by use of a metal shield to screen out γ radiation from the surrounding rock. Third, a control station was provided for biological experiments which require a milieu having the maximum possible freedom from radiation. High sensitivity nuclear plates developed after increasing exposure times furnished proof that during three years observation time not a single track from cosmic radiation could be detected. Physical measurements by ionization chambers showed a background of 0.2 ± 0.1 ion pairs/cm^3 of air/sec. This value is probably the minimum which could be accurately observed and has rarely been obtained at any other locality. Hence, these measurements show that a practically radiation-free environment is provided. Studies concerning the effects of subradiation on biological materials were designed using experimental subjects chosen according to a scale of their innate radioactivity levels: (1) Artemia salina eggs (low activity), (2) seeds of golden barley (Hordeum bonus 01518/B.19 (moderate innate activity), and (3) green algae (very high innate activity). The designation of the innate activity levels of the subjects was precisely determined by repeated analyses of their ashed residues. One group of subjects in each of these activity categories was held and observed for several years in the radiation-free milieu in the Simplon tunnel and later compared with that of control specimens kept at the surface of the earth. The results of these experiments showed that the subjects of Group 3 which have a high rate of innate activity are most sensitive to a change in milieu, while the first group exhibits the greatest resistance, after a period of irradiation, which decreases in a short time. It is concluded that when examination of the effects of weak radiation levels (environmental radiation) is to be made, the radioactivity of the subject itself must be taken into account. (BBB)

84 GRAVITY, RADIATION AND GROWTH. P. O'B. Montgomery, Eugene Rosenblum, and Betty Stapp (Univ. of Texas. Dallas and Woodlawn Hospital, Dallas). Aerospace Med., 35: 731-3(Aug. 1964).

Phage free E. coli B cells were exposed to continuous ionizing radiation from a ^{60}Co source which delivered 55.8 R per hour. Cells so treated show a depression of their growth curves when compared to unirradiated control cells. Ultrastructural observations indicate that these irradiated cells continue to enlarge despite their failure to divide. This enlargement involves the entire cell and its intracellular ultrastructural components. A comparison of these effects of x radiation and the effects of increased gravity on these cells was made. It is apparent that increased gravity and increased x radiation produce similar disturbances in the growth curves and in ultrastructural characteristics of E. coli B cells. The possibility that these alterations may be of a genetic nature is considered. (auth)

85 MICROWAVE HAZARDS EVALUATION. H. S. Seth and S. Michaelson (Univ. of Rochester, N. Y.). Aerospace Med., 35: 734-9(Aug. 1964).

The ever-expanding use of microwaves and utilization of greater and greater intensities calls for a periodic evaluation of microwave hazards. The present evaluation is based upon experimental animal data and observations on radar personnel in the armed forces and industry. The injury caused by microwaves is mainly thermal. Non-thermal effects were proved beyond doubt. Experimental irradiation of animals is very different from the actual exposure of man in radar operation. Also man, in comparison with experimental animals, has a much more efficient thermoregulatory mechanism. Extrapolation of animal data to man is, therefore, of limited value unless inter-species and intra-species variability is recognized and considered. Additional hazards such as those due to ionizing radiation and toxic agents have been considered. Proper engineering and lay-out of equipment, education of personnel and observance of certain precautions are practical and effective preventive measures which can be instituted without jeopardizing or interfering with radar operations. This should not lead to complacency and neglect of vigilance and search for possible ill-effects due to microwaves. (auth)

86 FOCAL RADIATION, A METHOD FOR INDUCING STRUCTURAL MODIFICATIONS IN THE IMMATURE RAT BRAIN. James A. Pulliam and Stanley R. Glasser (Univ. of Rochester, N. Y.). Anat. Record, 149: 609-22 (Aug. 1964).

A new and relatively simple technique for conducting developmental neurology experiments is described. This technique consists of subjecting rats less than four days in age to a collimated source of external beta radiation that can be directed to selected parts of the brain. Use of this method yields the following advantages: the size relationships of the parts of the brain can be altered, bilateral asymmetry of the cerebrum, and cerebellum can be produced, chronic functional defects which develop as the rat develops can be obtained, the experimenter may selectively destroy any site in the brain provided that it is superficial enough, and foci of epilation appear on the scalp and serve as markers. The limitations of this method are also discussed. (auth)

87 SOMATIC MUTATIONS INDUCED BY CHEMICAL MUTAGENS AND GAMMA RAYS IN HETEROZYGOUS BARLEY PLANTS FOR LOCI CONTROLLING CHLOROPHYLL SYNTHESIS. G. S. Ryan and H. Heslot (Instituto de Fitotecnia, Castelar, Argentine and Institut National Agronomique Paris). Ann. Amelioration Plantes, 13: 297-306 (1963). (In French)

Somatic mutation method in barley, as reported by Favret (1960), was employed with heterozygous plants for loci controlling chlorophyll synthesis. Mutagenic action of two chemicals (nitrogen mustard and ethyl methane sulfonate (EMS)) and of one physical agent (gamma rays) was studied on three loci, previously used, and for the first time on 12 mutant strains induced by EMS treatment. Different reactions were found according to the locus and the mutagenic agent employed. A significant increase in the number of mutant sectors was found after storage of seeds irradiated with gamma rays. Results show that the strict idea of $_{50}$LD for the calculation of concentrations and times of exposure in induction of mutations could be reexamined, in relation with environmental conditions of development of the treated seed. (auth)

88 GENETIC VARIABILITY IN AEDES AEGYPTI (DIPTERA: CULICIDAE). III. PLASTICITY IN LABORATORY POPULATIONS. Robert C. Vandehey (Univ. of Notre Dame, Ind.). Ann. Entomol. Soc. Am., 57: 488-96 (July 1964). (COO-38-376)

To assay the amount of hidden genetic variability in laboratory populations of Aedes aegypti (L.), single mosqui-

toes were selected from cage colonies and inbred by single-pair matings to the F_2 generation. The F_2 progenies were examined for individuals showing structural variations. These variants were tested for heritability by further inbreeding unless they were phenotypically similar to mutants previously isolated. Consistent use of this criterion permitted an objective comparison of the frequency of mutations in different populations. The samples analyzed contained 52 pairs selected from 4 laboratory strains. Over 22,000 mosquitoes from 424 F_2 families were examined for morphological mutations. A total of 137 mutations were estimated to be present in these samples. This gave a frequency of 1.32 mutations per individual. Small differences were observed in the total mutation loads carried by the different populations analyzed; a recently established colony had somewhat fewer mutations than colonies maintained in the laboratory for many years. However, the various populations could be characterized easily by distinct differences in the kinds of mutations each carried. Results of some preliminary tests for mutation frequency in an irradiated series are also given. (auth)

89 POSTIRRADIATION MELANONYCHIA. Walter B. Shelley, Howard M. Rawnsley, and Donald M. Pillsbury (Univ. of Pennsylvania, Philadelphia). Arch. Dermatol., 90: 174-6(Aug. 1964).

An unusual case of temporary melanin pigmentation of the fingernails is reported following superficial irradiation therapy of a hand dermatitis. Melanin can be differentiated from hemoglobin both chemically and microscopically. The clinical significance of melanonychia is reviewed. (auth)

90 ELECTRON MICROSCOPY OF ^{131}I-IRRADIATED THYROID. Harold J. Sobel (Albert Einstein Coll. of Medicine, New York). Arch. Pathol., 78: 53-60(July 1964).

A cytochemical study of ^{131}I-irradiated rat thyroid gland showed focal changes in the thyroid as early as two hr after intraperitoneal injection of 2 μC of carrier-free ^{131}I/g body wt. At this time the luminal surfaces of some acini revealed alkaline and nucleoside phosphatase activity, which was never observed in control animals. After eight hr an increase in number and a more widespread distribution of lysosomes were noted. Enlarged lysosomes were found in the Golgi zone of these cells after 24 hr, and the Golgi lamellae were frequently curled into spherical bodies at this time. Little change was noted in mitochondria, but changes were noted in the endoplasmic reticulum at 48 hr. To facilitate interpretation of these cytochemical changes, these preparations were also examined electron microscopically. The three-day postirradiation specimen was chosen because cytochemical changes were most marked at that time. Alterations were found in all organelles except mitochondria. Microvilli at the apex of thyroid acinar cells were degenerated and/or absent in focal areas. There were an increased size and number of lysosomes and an increased number of cytolysomes in many cells. The Golgi sacs of many of these cells were distended and surrounded by fewer vesicles than usual, and the endoplasmic reticulum formed oval profiles which were often clumped at the base of the cell and were partially denuded of ribosomes many of which were found free in the cytoplasm. Nuclei often appeared swollen and less electron dense. These changes are thought to be nonspecific alterations of injured thyroid acinar cells. Blood vessels did not reveal any alterations until 24 to 48 hr after administration of ^{131}I at which time the acinar cell changes were well developed; therefore, it was felt that these changes were produced directly by irradiation and were not secondary to vascular injury. These studies illustrate the similarity of the ultrastructural changes in thyroid glands injured by different agents. (BBB)

91 LIGHT-OPTICAL AND ELECTRON MICROSCOPE STUDIES OF THE DIRECT AND INDIRECT RADIATION EFFECTS ON CHICKEN EMBRYOS. R. Danneel and E. Wendt (Universität, Bonn). Atompraxis, 10: 434-6 (Sept.-Oct. 1964). (In German)

The morphological and physiological changes in irradiated cells are being studied to determine whether these changes are the result of direct or indirect radiation effects. Chicken embryos irradiated with 1200 R break down within several hours in the egg. Individual organs and tissues remain, however, intact. After explantation in tissue cultures, they grow completely normally and show in microscopic examinations no irreversible damage. If the heart tissue is removed, not immediately, but several hours after the irradiation, the growth of the cells in the tissue culture becomes increasingly poor. The heart also fails not by a direct radiation damage but succumbs gradually to an indirect injury by radiotoxin which originates in the blood and can be detected in various ways. This indirect radiation injury can be extensively eliminated by the injection of metabolism-inhibiting agents. It was strongly reversed when the embryo was treated before irradiation with metabolism-activating thyroxine. (tr-auth)

92 THE DOSE RANGE OF IONIZING RADIATION AT WHICH EARLY CYTOLOGICAL ALTERATIONS IN BONE MARROW MAY BE DEMONSTRABLE. F. Wendt and W. Otte (Universität, Freiburg i. B.). Bibliotheca Haematol., No. 19, 267-70(1964).

As a guide for the estimation of the dose in accidental exposure to radiation, quantitative changes in bone marrow cells were evaluated. Two types of changes are seen in elements in bone marrow within hours after exposure: (1) Cells of predominantly erythroid derivation which show nuclear destruction with loss of nuclear structure, homogenization of chromatin, and fragmentation of the nucleus so that drop-like fragments are seen within the cytoplasm; (2) Cells which show chromosomal aberration or separation of smaller portions of nuclear material. Rabbits were exposed to whole-body ^{60}Co γ radiation in doses up to 400 R. In the erythroid-myeloid ratio and lymphoid-myeloid ratio there was no significant deviation from the controls up to 200 R, and only a slight decrease in the latter ratio at 400 R was observed. The number of mitotic figures did not differ significantly in all dose groups for erythroid or for myeloid mitoses. The cellularity of the marrow specimens decreased with increasing dose. Cells with nuclear destruction were only very occasionally seen in nonirradiated animals. After exposure these cells increase, starting at 50 R, with the dose. Plotted on a log/log scale, a linear relation resulted between radiation dose and incidence of these pathologic cells for the dose range 50 to 400 R. Cells with chromosomal aberration very infrequently appeared in the control specimens, and increased with the radiation dose. These two pathologic cell elements were not observed in every case after exposure except in the 400-R dose group. It is pointed out that the time of taking the marrow specimen after exposure may be of great importance with regard to the rate of finding directly injured cells. Many of the directly injured cells will have been eliminated by the body within 12 to 18 hr. This time factor has to be taken into account in consideration of bone marrow alterations following radiation exposure. Nevertheless, it seems justifiable to recommend the quantitative evaluation of the pathologic cell elements in the bone marrow as described here. This may serve as an aid in the early diagnosis of the degree and evaluation of the prognosis in acute irradiation damage. (BBB)

93 TESTICULAR INJURY IN RATS IRRADIATED DURING INFANCY. A. Leonard, F. Imbaud, and J. R. Maisin (Centre d'Etude de l'Energie Nucleaire, Mol, Belg.). Brit. J. Radiol., 37: 764-8(Oct. 1964).

Rats eight or 17 days old were exposed to doses of 50, 150, 300, or 500 R whole-body x-irradiation. Half of each group of animals received AET intraperitoneally ten minutes before irradiation. The weight of the testes was determined by x-ray dose, by the age at the time of irradiation and by the injection of AET. The percentage of tubules without germ cells and the average number of spermatocytes per tubule were altered by high doses of x rays, while the average diameter of the tubules was not changed by irradiation. The histological damage in rats irradiated at 17 days was greater than in those exposed at 8 days. An injection of AET showed no protective effect against the histological injury at the time of analysis and for the

x-ray doses used. Testicular damage in rats irradiated during infancy could not be evaluated in terms of testes weight only, and during a certain time interval there was no correlation between fertility, structural changes and weight. (auth)

94 DOSE FRACTIONATION AND RECOVERY FROM X RAYS IN RHODNIUS. W. F. Baldwin and Evelyn L. Shaver (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Zool., 42: 515-18(July 1964).

In Rhodnius prolixus, molting delay is proportional to the radiation dose. Mitosis in the epidermis of this insect prior to molt is not initiated until the bug obtains a blood meal; thus, it is possible to irradiate the epidermis while all the cells are in interphase, and, by holding the insects in an unfed condition, to maintain the cells in this stage for periods up to several weeks or months. As daughter cells produced by division in the epidermis are responsible for forming the new cuticle, mitotic inhibition following irradiation is reflected directly in a delay in molting after a blood meal. It was shown earlier that recovery from radiation damage, of the kind that leads to delay in molting, does occur during interphase in the epidermis of Rhodnius; the present work was designed to investigate the effects of dose fractionation on recovery from x irradiation in interphase cells. The different treatments were: single exposure to 6000 R; divided exposure to 3000 R + 3000 R; and a single exposure to 3000 R. When the dose was split, the second half was given immediately before feeding. The data showed that recovery from the radiation-induced damage which delays the molt in Rhodnius is related to the interval between irradiation and feeding. The rate of recovery was rapid during the first 16 hours, as shown by the decrease of about two days in median molting time in all groups during this comparatively short period. However, an interval of 250 hr was required to produce a further comparable decrease in molting time. After single and divided doses of 6000 R the rate of recovery was comparable with both treatments. In both cases,the median molting time progressed from approximately 27 days at 0 time to 23 days at an interval time of 250 hr. At intervals greater than 250 hours, however, recovery from molting delay continued in the groups irradiated with single doses of 6000 R, whereas, in the divided dose, the amount of recovery was the same at 2048 hr as at 250 hr. After a single dose of 3000 R, the median molting time decreased rapidly, and at 250 hr was equal to the value for nonirradiated controls. Thus the recovery from radiation damage, as shown by a decrease in molting delay, occurred during mitotic interphase, when the epidermal layer of cells responsible for manufacturing the new cuticle was in a nondividing state. The absence of cell division made it possible to demonstrate recovery processes in Rhodnius without the complications found in tissues composed of dividing and nondividing cells. Therefore, a cell given the first fraction of a dose is the identical cell that receives the second or subsequent doses. (BBB)

95 EFFECTS OF LOW-LEVEL GAMMA-RADIATION ON THE IMMATURE STAGES OF DAHLBOMINUS FUSCIPENNIS (ZETT.) (HYMENOPTERA: EULOPHIDAE). D. F. Riordan (Canada Dept. of Agriculture, Belleville). Can. J. Zool., 42: 675-84(July 1964).

Since little information is available on the effects on insects of relatively low radiation doses administered at low rates, these experiments were designed to provide such data. In preliminary experiments to those in which insects were irradiated continuously throughout their life cycle, it was determined whether there are any times during development at which the immature stages are particularly susceptible to damage at low dose rates. Immature stages of the chalcid were irradiated for 24 hr on each of the first 16 days of development at dose rates of 12, 24, and 48 R/hr. It was calculated that the numbers of females available to be mothers of the F_2 generation would be reduced by 94%, 84%, and 42%, respectively, at the three rates of dosage, when irradiation was commenced within 24 hours after oviposition. The greatest damage was produced by irradiation at 48 and 24 R/hr during days one, two, or three when the insects are eggs or very young larvae or when hatching would be taking place. After day three, resistance rose steadily until it reached a peak coinciding with the late larval stage, which is probably a time of developmental rest. Resistance to irradiation at all dosages decreased through the pupal stages, in fact, for the 12-R/hr dosage the lowest survival values were reached on days 14 to 16. The numbers of male adults from unmated mothers showed some reduction from irradiation at 48 R/hr, notably for irradiation days one, two, and three when the numbers were reduced to 67, 49, and 67%, respectively, as compared with the nonirradiated controls. There was evidence of another effect, namely, that irradiation lowered the vitality of the ensuing all-male populations, as in many cases they failed to emerge from the host cocoons. Females irradiated at immature stages failed to parasitize the hosts provided (Neodiprion), and examinations of hosts from which no parasites emerged failed to reveal the presence of unhatched eggs or dead larvae. Thus it is considered that complete sterilization of some females occurred, and many females not sterilized laid fewer viable eggs than the controls. The only effect definitely demonstrated in those males surviving irradiation in the immature stages was complete sterility. A prominent effect on the progeny of irradiated mated mothers was an increase in the average numbers of male progeny. (BBB)

96 ANALYSIS OF MITOSIS IN SOYBEANS DURING THE INITIAL STAGES FOLLOWING X-IRRADIATION. Shui Hao, Su-chin Feng, Fu-jung Chang, Yu-hsin Wang, and Ching-chun Yang. Chih Wu Hsueh Pao, 11: 207-16(1963).

Irradiation of Vicia faba with a dose of 500 R produced a gradual decrease in the mitotic index, first becoming apparent 1 hr after irradiation and reaching 66% of normal in 3 hrs. Analysis of the individual stages showed decreased prophase and increased metaphase 3 minutes after irradiation, due probably to progression of interphase cells to metaphase. Increases in anaphase and telophase appeared 30 minutes and 1–3 hr after irradiation, respectively, while the percent metaphases decreased; 3 hr after irradiation the percent prophase was also increased markedly. (OTS)

97 RADIATION HAZARDS IN PERSPECTIVE. Chron. World Health Organ., 17: 49-54(Feb. 1963).

Radiation hazards to human health are reviewed against a background of other man-made and natural hazards. Many man-made hazards result from the introduction of new processes and the use of new materials that have themselves largely contributed to a rapid improvement in the health and life expectation of populations. Most injuries caused by chemical toxins have occurred as a result of industrial exposure, and some of these closely resemble radiation injuries. Thus, erythema, one of the early signs of radiation injury, may be caused by a vast number of chemical irritants. The connection between malignant disease and exposure to toxic chemicals or radiations is discussed. Although sunlight, particularly in uv wavelengths, is known to cause skin cancer, there is as yet no evidence that ionizing radiation from natural sources (unless concentrated, as in the case of purified Ra) has any effect on the cancer rate in man, even where it is abnormally high. However, in certain central European mines, lung cancer has been encountered, and this is now attributed to the radioactive decay products of Rn gas, inhaled along with dust. It is shown that a wide variety of environmental agents other than ionizing radiations can cause or predispose to cancer, or are suspected of so doing. Genetic effects of radiation are discussed, and studies on mutagenesis in mammals that have been conducted with radiations are reviewed. The shortening of the life-span following exposure to radiation, so far observed only in experimental animals, is also discussed. No such effect has yet been confirmed in radiologists or among survivors of the atomic bomb explosions in Japan, but the numbers studied are perhaps too small and the period of observation too short to reveal an effect of this kind. In animals, the overall shortening of the life-span appears to be related

to the cumulative dose of radiation and to be due to an earlier incidence of all causes of death, and not merely to an increased incidence of diseases known to be caused by radiation. The mechanism responsible for the shortened life-span has not been elucidated, but there is some evidence that certain phenomena known to be associated with aging, such as changes in the arterioles and capillaries, occur earlier in irradiated animals. Such signs of premature aging have also been observed occasionally in men suffering from chronic lead or carbon disulfide poisoning. It is important to establish by adequate statistical studies whether exposure to radiation or other toxic materials can, in fact, shorten the life-span, although any such effect is likely to be very small compared with the great increase in life expectancy that has resulted from recent medical progress. The conclusion of this review of radiation and toxic hazards in the environment is that risks are an unavoidable accompaniment of developments in medicine and technology. Drugs capable of saving large numbers of lives may, under some circumstances, cause injury and death; and ionizing radiation, though a valuable tool in therapy and diagnosis, may occasionally lead to injury and malignant change. It is essential to balance the hazards against the benefits, but this can only be done if the hazards are precisely known. (BBB)

98 COSMIC RADIATION AND TUBERCULOSIS. Shan-yuan Wang. Chung Kuo K'o Hsueh, 13: 241-58(1964).

Repeating previous studies, the effects of cosmic radiation at different altitudes on the course of tuberculosis in mice were investigated. Mice received 0.28 mg of strain H37Rv bacillus by injection at sea level and were then transported to 2300 meters, where percentage surviving, mean survival time, and extent of pulmonary and splenic lesions (rated on a 0–4 scale) were compared with similar parameters for mice receiving the identical injection at 2,300 meters. Animals were maintained in wooden structures without iron, but shielding from cosmic rays was obtained by interposing 1, 2, or 10 cm Pb, and mice were kept either in daylight or in the dark. All animals gained weight. The mean mortality was lower and mean survival time greater for the mice infected at sea level. These results suggest but do not prove statistically that lead screening and exposure to daylight are favorable treatment parameters with respect to survival. The percentage survival was greater for males infected at high altitudes than for females, but intersexual differences were not significant among the mice infected at sea level. On the other hand, mean survival time was greater for females infected at sea level and transported to 2,300 meters, the reverse being true for animals infected at high altitudes, differences in treatment being statistically insignificant. No correlation between lung and spleen lesions was observed; but a negative correlation was found between lung lesions and survival time and a positive correlation between spleen lesions and survival time. A second series of experiments involving inoculation and maintenance of mice at sea level showed the following: weight had a tendency to decline after an initial increase; mortality was not significantly different between treatments; a greater percentage of females survived; and the mean survival time of females was also greater. There was a positive correlation between lung and spleen lesions; however, lung lesions declined as survival time increased and spleen lesions increased with increasing survival time. Altitude is thus a significant factor in the sense of increasing survival time of tubercular mice and percent surviving. (OTS)

99 COSMIC RADIATION AND TUBERCULOSIS. Shan-yuan Wang. Chung Kuo K'o Hsueh, 13: 259-61(1964).

Mice surviving treatment with bacilli irradiated under 2.1, 7.4, and 9.5 cm Pb were subjected to a second series of injections, this time with virulent tubercle bacilli. Analysis of variance of survival times of the 4 different groups of mice (control, 2.1, 7.4, 9.5 cm Pb) after suitable normalization of the experimental data to correct for skewness showed that the mean survival time of the immunized mice was significantly greater than that of the controls; and that the mean survival time of the 9.5 cm Pb-group was significantly greater than that of the other two immunized groups. The average weight of mice in the 9.5 cm Pb group was also significantly greater than that of the other groups. Attenuation of virulence and immunizing properties are thus conferred upon tubercle bacilli irradiated under lead screening, optimum effects being attained with 9.5 cm Pb. Repeated exposure of bacilli to cosmic radiation under this screening should result in an antituberculosis vaccine. (TCO)

100 COSMIC RADIATION AND TUBERCULOSIS. Shan-yuan Wang. Chung Kuo K'o Hsueh, 13: 263-7(1964).

Strain H37Rv tubercle bacilli, inoculated in a potato-egg medium, were subjected to high-altitude (2300 m) cosmic radiation for 104 days, directly or under 1, 2, or 10 cm Pb screening followed by incubation for 28 days at 37°C at sea level. Injection of 0.5 or 1.0 mg of the irradiated tubercle bacilli into mice showed that the mortality rate (virulence) increased in the following order: direct-irradiation at 2300 meters, direct-irradiation at sea level (controls), and irradiation through 1, 2, and 10 cm of Pb. The mean survival time was also highest for the first group. The mortality was directly related to dose. The survival time was greater for females than for males on the average, but not uniformly so when the varying conditions were taken into account. Reinfection experiments on survivors of the four test groups and on control mice with the same groups of bacilli as those used originally showed a reduction in virulence of the shielded (2 cm and 10 cm Pb) bacilli to below that of the controls (sea-level irradiation). The presence of interaction between sex and treatment made it impossible to isolate the effect of sex on survival. (OTS)

101 RADIATION EFFECT ON PROTEIN SYNTHESIS AND RNA METABOLISM IN RETICULOCYTES IN VITRO. S. Robev and G. Dessev. Compt. Rend. Acad. Bulgare Sci., 17: 57-60(1964).

The rate of protein synthesis and RNA content of irradiated reticulocytes in physiological solution were studied using ^{32}P-phosphate and ^{14}C-phenylalanin as tracers. The amount of RNA was found to be considerably higher in irradiated samples than in controls. No difference was found in the rate of incorporation of ^{14}C-phenylalanin into globin of irradiated and control samples. It is pointed out reticulocytes present a convenient model for molecular biological investigations as they primarily synthesize hemoglobin, whose structure is determined genetically. The possible role of messenger RNA in protein synthesis in reticulocytes is discussed. (C.H.)

102 STUDIES ON VARIATION IN NUMBER OF ANAL FIN RAYS IN ORYZIAS LATIPES. EFFECT OF X-IRRADIATION. Nobuo Egami (Inst. of Radiological Sciences, Chiba, Japan). Copeia, No. 3, 592-3(Sept. 25, 1963).

Experiments designed primarily to study the effect of x-irradiation on the development of endocrine organs in Oryzias latipes showed a considerable reduction in the number of anal fin rays in the irradiated groups. Eggs in various developmental stages were given 62.5, 125, 250, 500 or 1000 R doses of x radiation. The number of anal rays on each fin was counted on the 30th day postirradiation. When eggs were irradiated with 500 R or more, the incubation period was prolonged and the growth rate of the young was strongly inhibited in all groups. It is concluded that irradiation is one of the environmental factors controlling the number of meristic characters of the fish and that the components of the particular characteristic are modified by disturbances of developmental processes during embryonic development. (H.M.G.)

103 EFFECTS OF METHIONINE AND ESTROGEN ON HEMORRHAGES INDUCED BY FEEDING OF IRRADIATED BEEF. Om P. Malhotra, Elwood F. Reber, and Horace W. Norton (Univ. of Illinois, Urbana). Cornell Vet., 54: 370-82(July 1964).

In tests of the wholesomeness of irradiated beef, it was previously reported that male but not female rats died of hemorrhage when they were fed irradiated beef. The prothrombin times were prolonged, and vitamin K reduced in rats fed irradiated beef. The protective effect of estro-

genic hormones in vitamin K deficiency has been reported, and in vitamin K-deficient dogs, DL-methionine increased the accelerator (factors V and VII) activity. Moreover, DL-methionine, added to the ration containing irradiated beef, reduced the mortality and prolonged prothrombin times in rats. Therefore, experiments were designed to evaluate the relation between DL-methionine and estrogen on the occurrence of hemorrhagic diathesis in orchiectomized rats fed irradiated beef. Orchiectomized rats were used to eliminate the effects of the endogenous testosterone. Moreover, graded levels of estrogen and DL-methionine were used to determine their effects without affecting the growth of the rats. Ground nonirradiated or irradiated (2.79 or 5.58 Mrad) beef was incorporated into a ration at a level of 35%. In the first experiment, the rats were fed a ration containing beef irradiated with 5.58 Mrad (B6) for 20 weeks. The second experiment was a replication of the first, but because of a shortage of B6, beef irradiated with 2.79 Mrad (B3) was substituted after the rats had been on the experiment for 10 days. The rations were supplemented with 0, 0.69, 1.37, or 2.06% DL-methionine, and the rats received 0.06, 0.3, or 1.5 μg of estrogen (estradiol cyclopentylpropionate) subcutaneously three times a week. The mortality rate in rats fed a ration containing the B3 irradiated beef without supplemental methionine was significantly less than in rats fed the B6 ration, the difference being decreased with increasing doses of estrogen. Estrogen significantly reduced mortality. Mortality data on the 20-week study of rats fed B6 showed that both methionine and estrogen reduced the number of deaths linearly (departure from linear regression was not significant) and significantly. There was no apparent interaction between estrogen and methionine. The prothrombin rate was normal in B3 fed rats and was not influenced by methionine or estrogen administration. In B6 fed rats, however, the prothrombin rate was affected significantly by methionine, decreasing when methionine was added to the ration at the 0.69% level, but increasing when added to 2.06%. In addition, estrogen administration significantly increased the prothrombin rate in proportion to the dose injected. Rats fed B6 ration gained more body wt than rats fed a ration containing B3. Estrogen administration linearly depressed the growth rate; however, methionine decreased the growth rate, but nonlinearly. These effects were observed on both the B3 and B6 rations. (BBB)

104 RADIATION EXPOSURE AND RADIATION HAZARDS OF THE EYE. E. Krokowski and U. Ehling (Freie Universität, Berlin). Deut. Med. Wochschr., 87: 2081-6(Oct. 12, 1962). (In German)

The possible sources of radiation exposure of the eye encountered through research, industry, and technology, as well as in medical diagnosis and treatment, and in cases of nuclear catastrophe are reviewed. Attempts were made to determine the most sensitive part of the eye and the maximum permissible radiation doses per annum and per lifetime. It is recommended that in therapeutic use the concept of the deep-dose curve be replaced by the dose-effect curve. As it was found that no x-ray examination will reach the maximum permissible dose accepted for the eyes, it is more important to limit the annual exposure to the eyes to 8 to 16 R; this applies to doctor and patient alike. A radiologist should not exceed 2.5 hr viewing time per day. Persons working with radioactive materials in industry should exercise caution, and the wearing of lead-shielded glasses is recommended. This precaution, however, is not necessary for radiologists. Experiments showed that ionizing irradiation affects the water content of the lens and causes clouding. The water content of the normal lens is 60 to 66%; in case of opacification of the equatorial zone it is still 60 to 66%, with opacification of the outer zone 67 to 75%, and total opacification > 75%. It is recommended that total exposure should not exceed 20 R/yr; this includes that caused by television, medical examination, and irradiation from luminized dials. In industrial use the upper limit is 30 R/hr. The minimum age limit in industry is 18 yr, and the length of employment in jobs requiring exposure is 8 yr, at which time the maximum permissible dose of 250 R may be reached. (BBB)

105 EFFECTS OF IONIZING RADIATIONS UPON THE SODIUM METABOLISM IN GOLDFISH CARASSIUS AURATUS. C. Tachi (National Inst. of Radiological Sciences. Chiba, Japan). Dobutsugaku Zasshi, 71: 322-7 (Oct. 15, 1962). (In Japanese)

Experiments were made on the net sodium loss of the irradiated and non-irradiated goldfish. The animals used were Japanese common goldfish (Wakin) weighing 3 to 5 g. Irradiations were carried out with γ rays from ^{60}Co. Conditions of irradiation are as follows: dose rate 213 R/min, without filter, ten animals were irradiated at the same time in a plastic cylindrical vessel, 6 cm in diameter and with water measuring 2 cm in depth. After the irradiation, the animals were transferred in 500 ml of deionized water, in which they had been kept for 15 days without change of water and food supply. Samples of 5 ml water media were collected on different post-irradiation days. The loss of water by evaporation was made up by daily addition of comparable amounts of deionized water. This procedure was carried out 3 to 4 hr before the sample collection. Concentrations of Na^+ and K^+ were determined with Hitachi flamephotometer. Irradiated goldfish with 5325 R showed a characteristic daily pattern of net Na^+ loss, which is quite different from that of the non-irradiated animals. The irradiated fish lost much greater amounts of Na^+ than the controls. The experimental animals died within 8 to 12 post-irradiation days after loss of 500 to 750 μg of Na^+. Irradiation with 1065 R did not result in a typical sodium reaction. Dose range where the sodium reaction occurred seems to be in accord with that of 10-day effect in goldfish, the dose range which causes the death of the animals within 8 to 12 post-irradiation days. Remarkable changes in the net K^+ excretion after irradiation were not observed. Further tracer experiments suggest that destruction of the intestinal epithelium by radiation is not so serious in goldfish as to cause disturbed Na^+ transport, and not essential for the sodium reaction. Mechanical destruction of the skin by rubbing the animals with dry absorbent cotton, caused the increased net Na^+ loss in the experimental animals. Histopathology of the irradiated skin revealed that the animals showing the sodium reaction were suffering from the damages of their epidermis. The tissues were fixed in Bouin's solution on 10th day after irradiation. These facts, taken together, seem to suggest that the primary cause of acute radiation death in goldfish is the abnormally increased Na^+ loss from the destructed skin. Further experimental investigations, however, especially those on Na^+ absorption capability of the gills, are requisite for the conclusive discussion. (auth)

106 THE AGE RADIOSENSITIVITY OF MICE OF DIFFERENT LINES. I. A. Nechaev (Inst. of Genetics, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 158: 214-17(Sept. 1, 1964). (In Russian)

At an age of 2.5 months, the $DL_{50/30}$ value is 440 R for the BALB/c line, and 538 R for the CC57 Br line of mice. The radioresistance of the two lines differs considerably. In order to discover the particulars of age radiosensitivity, mice of both sexes from each line having ages of 1, 15, 30, 45, and 60 days were given a single, whole-body, x-ray dose of 300, 400, 500, and 600 R. The newly-born mice showed the greatest radioresistance with a $DL_{50/30}$ value of 450 ± 13 R for the BALB/c line, and 535 ± 14 R for the CC57 Br line of mice. The 30 and 50 day mice showed the highest radiosensitivity in both lines. The difference in radioresistance between the two lines was maintained. The DL_{50} of the radioresistant CC57 Br line was higher than the DL_{50} of the radiosensitive BALB/c line. The gastroenteric system was much more sensitive to radiation damage in 30 to 40 day mice than in newly-born and 15 day mice. A shift in the radiation sickness syndrome was observed with age. Thus, the 15 day mice showed loss of hair 7 to 12 days after irradiation with a dose of 400 R or higher. The newly-born mice irradiated with a 400 R dose showed normal hair development. (TTT)

107 HOMOTRANSPLANTATION OF THE ADRENAL TO THE PORTAL CIRCULATION IN THE RAT. Donald E. Bernstein (Mount Zion Hospital and Medical Center,

San Francisco, Calif.). Endocrinology, 75: 812-14(Nov. 1964).

Previous investigations from this laboratory demonstrated that autotransplants of the rat adrenal to the mesentery of the small intestine were successful in practically all instances. Moreover, in the female, such grafts invariably hypertrophied and showed extensive hyperplasia of the cortical cells. The present investigations on adrenal homotransplantation to the mesentery showed that takes occurred in more than half the adults from our inbred colony, and, in females, a marked hypertrophy of the adrenals was observed. When newborn adrenals were transplanted to unrelated rats of the same strain, the takes generally occurred in less than a third of the hosts, and the females in this group also showed a marked hypertrophy of the adrenal implants. Irradiation of the newborn adrenal before intraportal implantation increased the number of takes in the male, but neoplasia was not observed in any of the homotransplants even after a period of observation of one year. (auth)

108 SUPPRESSOR GENE ACTION IN THE TRYPTOPHAN SYNTHETASE SYSTEM OF NEUROSPORA CRASSA. I. GENETIC STUDIES. Joseph D. Yourno and Sigmund R. Suskind (Johns Hopkins Univ., Baltimore). Genetics, 50: 803-16(Nov. 1964).

Tryptophan synthetase (TSase) Neurospora crassa mutant td_{201} requires either indole or L-tryptophan for growth. It produces high levels of crossreacting material (CRM) which retains indole + L-serine → tryptophan activity. Two classes of tryptophan-independent colonies were found following ultraviolet irradiation and plating of conidia on minimal sorbose agar: isolates which exhibit the genetic, nutritional, and enzymatic properties of the wild type; and isolates which grow slowly on minimal medium and which are stimulated by DL-tryptophan or indole. Extracts of all slow-growing strains, while retaining the high indole + L-serine → tryptophan activity characteristic of td_{201}, contain about 10 percent of the wild-type level of indoleglycerolphosphate + L-serine → tryptophan activity. Seven independent isolates of the second type carried an unlinked suppressor as judged by tetrad or random-spore analysis of the progeny from crosses of wild-type by slow-growers. The seven suppressors are allelic or closely linked, since no td_{201} su^{+}_{201} progeny were detected by random single-spore analysis or mass plating of spores from td_{201} su_{201-s} × td_{201} su_{201-s} or td_{201} su_{201-s} × td^{+} su_{201-s} crosses. Furthermore the suppressors show approximately the same degree of linkage with several markers in linkage group VII. The td_{201} suppressors exhibit stringent site-specificity. They do not affect a number of different biochemical and morphological mutants or several other TSase mutants. (auth)

109 THE EFFECT OF MATING INTENSITY ON MUTATION FREQUENCY PATTERNS DETECTED AFTER IRRADIATION OF DROSOPHILA MELANOGASTER MALES. G. Lefevre, Jr. and Ulla-Britt Jonsson (Harvard Univ., Cambridge, Mass.). Genetics, 50: 879-90(Nov. 1964).

The patterns of mutation frequencies detected at daily intervals following irradiation of adult males with 4,000 R are strikingly affected by the mating regimen that is subsequently applied to them. This fact implies that differential mutability, not recovery from the genetic effects of irradiation, is responsible for the U-shaped mutation frequency curve observed after irradiation. When males are allowed to mate but once a day, the successive sperm samples generally contain a mixture of sperm derived from cells that were at different stages of maturity at the time of irradiation. Thus, the variation in mutation frequency at successive intervals after irradiation is minimal. Only when irradiated males mate several times each day is it possible to obtain sperm samples derived more or less homogeneously from single stages of spermatogenesis. Even then, if mutation frequencies are collected on a daily basis, changes within a 24-hour period are completely obscured. Optimally, irradiated males must be provided each day with a succession of virgin females so that observed matings can be obtained and mutation frequencies determined separately from each consecutive insemination. When this technique is adopted, the mutation frequency is seen to change drastically within the course of the first three matings after irradiation of 3-day-old males, beginning with the high mutation frequency characteristic of fully mature, motile sperm (4 percent per 1,000r), but falling to the much lower level characteristic of immotile, immature sperm stages (1.6 percent per 1,000r). By the fourth or fifth day after irradiation, if the mating schedule is properly adjusted, the mutation frequency rises again to a level as high as (or higher than) that characteristic of mature sperm as germ cells irradiated in the highly mutable early spermatid stage come to be sampled. Although the pattern of mutation frequencies is strongly affected by mating intensity following irradiation of adult males, the overall mutation frequency is not, so long as the entire population of postmeiotic germ cells is sampled. (auth)

110 ALLELIC COMPLEMENTATION AT THE ADENYLOSUCCINASE LOCUS IN SCHIZOSACCHAROMYCES POMBE. Roland Megnet and Norman H. Giles (Universität, Bern and Yale Univ., New Haven). Genetics, 50: 967-71(Nov. 1964).

Sixteen mutants were studied at the ad-8 locus of the yeast Schizosaccharomyces pombe. This locus, which corresponds to the ad-4 locus of Neurospora crassa, controls the enzyme adenylosuccinase (adenylosuccinate AMP-lyase) which catalyzes the ultimate reaction in purine biosynthesis leading to adenosine-5′-phosphate. All mutants were tested in all possible pairwise combinations for their ability to complement in diploids. Ten of the mutants do complement, and the results of these tests can be summarized in a linear complementation map. The order of the mutants on the complementation map agrees, with two exceptions, with the order on the recombination map. (auth)

111 BIOCHEMICAL AND MORPHOLOGICAL MUTANTS OF ASCOBOLUS IMMERSUS. Clare C. C. Yu-sun (California Inst. of Tech., Pasadena). Genetics, 50: 987-98(Nov. 1964).

Eight biochemical mutants and 16 morphological mutants were obtained in the heterothallic ascomycete Ascobolus immersus after x-ray or ultraviolet irradiation of ascospores from wild strains. Six of the biochemical mutants require amino acids and one requires a nucleic acid component. There was a preponderance of colonial mutants among the morphologicals. Both the biochemical and morphological mutants are due to mutations of single genes. Genetic data indicate three linkage groups, with two loci in each of groups I and II and four loci in group III. Mating type and w-1 are closely linked to their respective centromeres. (auth)

112 A CASE OF LATE CARCINOMA AFTER SEVERE DAMAGE FROM X RADIATION EPILATION. H. Kuenlen (Staedtische Krankenhauses Muenchen rechts der Isar, Munich). Hautarzt, 13: 220-3(May 1962). (In German)

A 48-yr-old patient had received an unrecorded dose of x radiation at age 6 for treatment of a scalp disease. A radiation ulcer about the size of a small saucer, appeared at the site of irradiation one day later. The patient soon became bald. Three other children, irradiated at the same time, died soon after the treatment. The radiation ulcer never healed over the 42-yr interval when, finally, the patient was admitted after suffering a paralytic stroke. Histological examination of the skull indicated a cornified squamous cell carcinoma. This was treated with 5700 R of soft x radiation given in 19 exposures of 300 R each, to control the exophytic portion of the tumor without destroying brain tissue located below the areas of the skull invaded by the tumor. Improvement was observed after 3 weeks. However, after 6 weeks the patient died. The original dose that the patient had received was estimated, in the absence of records, to have been at least 2000 R, considering that the initial ulcer appeared within one day after the radiation exposure. The latency period between irradiation and tumor appearance was rather extended in comparison to values

from the literature which report latency periods that vary from 7 to more than 30 yr. (BBB)

113 MALFORMATIONS CAUSED BY IONIZING RADIATION. Heinz Kriegel (Heiligenberg-Institutes, Ger.). Hippokrates (Stuttgart), 34: 89-92(Feb. 19, 1963). (In German)

Discussion is presented on the teratogenic effects of ionizing radiation on embryonic injury and the relation to dose level and to the developmental state of the embryo. Disturbances of embryonal development by irradiation of the ovum in utero are determined by its phase of development. The most radiosensitive phase is the preimplantation period. Irradiated morula and blastula stages do not usually survive the gastrulation phase. Radiation effects are different after implantation when malformations and organ anomalies instead of death usually result. Irradiation during the second half of embryonal development produces anomalies or defects of the extremities and skeleton including vertebral fusion, kyphosis, lordosis, polydactylism, brachydactylism, or syndactylism. Phocomelia is very rarely seen. Probably the greater radiation sensitivity of the underdeveloped fetus is not related to its rapid rate of cell division so much as it is to its metabolic and differentiation capacities. (TCO)

114 EXPERIMENTAL STUDIES ON STEREOTAXIC DESTRUCTION OF BASAL GANGLIA BY IMPLANTATION OF COLLOIDAL RADIOACTIVE ISOTOPES. Noburu Hoshino and Matsuru Fukunaga (Hiroshima Univ.). Hiroshima J. Med. Sci., 12: 151-4(Dec. 1963).

A method was explored to produce a small circumscribed lesion in deep cerebral ganglia in stereotaxic surgery. A lesion of the proper size could be produced by implanting a small amount of radiocolloid into the brain. The radiation source was prepared from Amberlite IRA-400, an anion exchange resin, in particles of 0.1 to 1.0 μ in dia, mixed with $Na^{131}I$ or $H_3{}^{32}PO_4$ solution. Then, 0.1 ml of colloidal suspension containing 50 mg of radioactive resin was injected into the globus pallidus of cats by the aid of a stereotaxic apparatus. The decay of radioactivity in the brain was reduced by half in two days and thereafter coincided with the natural decrement in the case of ^{131}I. In the case of ^{32}P the activity decrement coincided almost with the natural decay rate. In controls implanted with inactive resin no mortality was seen. In the group with 1-mC ^{32}P implantation, early deaths were also relatively few. Even when 5 mC of the isotopes were implanted, there were few deaths in the case of ^{131}I, but when 5 mc of ^{32}P were implanted all animals died within one week. Decrease in white cell count was seen in about half of the animals, but it recovered within one month. There was nothing of particular interest in the general condition and neurologic symptoms of these experimental animals. When the radioactive resin was injected, various degenerative changes could be found corresponding to the intensity of the injected radioactivity as well as time intervals between implantation and examination. The lesions were sharply demarcated from the normal tissue. After injection of 5 mC ^{131}I the diameter measured about 8 mm. In cases of ^{32}P implantation, focal destruction of the brain was intense, and edema was marked. (BBB)

115 APPLICATIONS OF INTENSE RADIATION SOURCES TO FOODS AND BIOSYNTHETIC MEDICINES. II. Robert Mouton (Université, Brussels). Ind. At., 8: No. 7-8, 103-8(1964). (In French)

The potentialities and limitations of the applicability of nuclear radiation to biosynthetic foods and medicines were investigated. Studies on physical, chemical, and biological treatments that can supplement the relative efficiency of radiations with respect to enzymes are reported. Researches on treatments combined with antimicrobic and antienzymatic action are also considered. (J.S.R.)

116 RADIATION-INDUCED GENETIC AND PHYSIOLOGICAL COLOR CHANGES IN JUTE. Rabindra Krishna Basu (Bose Inst., Calcutta). Indian J. Genet. Plant Breeding, 24: 42-50(Mar. 1964).

Color changes in jute induced by x rays and by β rays from ^{32}P and ^{35}S are described. Dry seeds of three pure breeding varieties, Tall Mutant, R. 26, and Chinsura Green, belonging to Corchorus olitorius and D. 154 and D. 386, belonging to C. capsularis L. were treated with doses ranging from 6×10^3 R to 90×10^3 R of x rays, from 0.005 to 7.500 μC per seed of ^{32}P, and from 0.500 to 7.500 μC per seed of ^{35}S. The x irradiated and ^{32}P treated populations were observed to manifest color changes which could be classified as chlorophyll mosaicism and color (anthocyanin) variants and/or mutations. No such changes were observed in the ^{35}S treated populations. The frequency of plants with chlorophyll mosaic leaves, and the intensity of the colors in them, increased with increase in dosage above 32,000 R of x rays and 5.0 μC ^{32}P per seed. Evidence is presented that the color effects were due to irradiation only. Anatomic studies of the chlorophyll mosaic leaves revealed more injury in the palisade and chloroplasts than the rest of the tissue. Color variants often manifested very intense anthocyanin pigmentation, unknown to these species, and in extreme cases the change in pigmentation proved to be lethal. A new scarlet-colored mutation, simulating the variety Tall Mutant, was isolated in ^{32}P-treated material. This was named Tall Mutant II. Inheritance studies indicated that Tall Mutant II is a dominant, heterozygous mutation, which segregated in the usual monohybrid ratio in appropriate crosses. From breeding experiments it was confirmed that the pigmented groups of C. olitorius namely, Chinsura Green (full green), R. 26 (light red), Tall Mutant and Tall Mutant II (scarlet) form a multiple allelomorphic series with scarlet dominant over both light red and full green and light red dominant over full green. It was possible to discriminate Tall Mutant II from R. 26 by leaf measurements by suitable discriminant function. Tall Mutant II has, further, been shown to be an early flowering type, compared to Tall Mutant. Both these are late types compared to R. 26. (BBB)

117 ON THE CLINICAL STATUS OF RADIATION REACTIONS IN THE INTESTINE AND THE URINE COLLECTION SYSTEM AFTER IRRADIATION OF THE LOWER ABDOMEN. H. Reme (Staedtische Krankenhauses, Ost Luebeck, Ger.). Internist, 4: 168-77(May 1963). (In German)

Radiation reactions were studied in a clinical series of 28 intestinal and 54 ureteral injuries. The frequently long interval between irradiation and the reaction to it often makes not only the diagnosis difficult, but also the decision as to what treatment to use. The reactions that appear in the intestines or ureters during or shortly after the radiation exposure may disappear spontaneously. However, late inflammatory reactions that appear in the intestine after 3 months to 7 yr, or in the ureters after 4 months to 32 yr, usually require surgical intervention. The principal clinical symptom in the intestine is acute or chronic obstruction and hemorrhage. In the ureter it is constriction, resulting in congestion of the kidneys. The decision whether radiation injury or tumor recurrence is the reason for the complaints and functional disturbances of intestine and ureters is difficult. Studies made of 54 ureteral stenoses showed that about 20% of the tumor-free women who had been irradiated for genital carcinoma died of urological complications. In women with neoplastic recurrences their complaints can be abated and their lives prolonged by palliative measures. It is not suitable to neglect taking therapeutic action. (BBB)

118 EFFECT OF X-RAYS IN SMALL DOSES ON THE PENETRABILITY OF ROOTLETS OF VICIA FABA. N. G. Nor-Arevyan. Izv. Akad. Nauk Arm. SSR., Biol. Nauki, 16: No. 12, 75-7(1963). (In Russian)

The rootlets of Vicia faba were exposed to x-irradiation in doses of 1, 5, 10, 150, and 1000 R, and then transferred into a solution of Na_2-HPO_4 containing radioactive P. The penetrability of rootlets of the V. faba in comparing with the control was depressed 14% under x rays with the 5 R dose and up to 32% after the 150 R dose. (H.M.G.)

119 γ-GLOBULIN AND ANTIBODY FORMATION IN VITRO. IV. THE EFFECT OF THE SECONDARY RE-

SPONSE OF X IRRADIATION GIVEN AT VARYING INTERVALS AFTER A PRIMARY INJECTION OF BOVINE γ-GLOBULIN. G. J. Thorbecke, E. B. Jacobson, and R. Asofsky (New York Univ., New York). J. Immunol., 92: 734-46(May 1964).

The effects on the secondary immunologie response obtained by varying both the time of x irradiation and reinjection of antigen were studied in New Zealand rabbits. When x irradiation is given a sufficient length of time after the primary injection of bovine γ-globulin (BGG), a pronounced and permanent reduction of the ability to respond to a subsequent booster injection could be obtained. It was also demonstrated that with a shorter time interval between primary injection and irradiation such suppression can only be demonstrated for a few days, most strikingly at 48 hr, and is then followed by a rapid recovery of the ability to produce a booster response. This recovery was correlated with the destruction and reappearance of secondary nodules in the white pulp of the spleen. Since it has been shown earlier that small lymphocytes can become transformed into large lymphoid blast cells under the influence of antigen, this delayed effect of x irradiation could be explained by postulating that damaged lymphocytes die from the irradiation within a certain period of time unless they are transformed during this time into blast cells which (in contrast to the small lymphocytes) possess the ability to recover from irradiation. It may not be possible to account for such a cellular damage and recovery phenomenon by means of the well-known effect of irradiation on DNA alone. Other irradiation effects, such as the depression of cytoplasmic oxidative phosphorylation, may play a role. These experiments suggest that the medium-sized lymphocytes found in secondary nodules are of importance in supplying cells which are able to react to the booster injection. The possibility was considered that the persistence of antigen in the tissues at 8 days after the primary injection is responsible for the fast recovery from the irradiation effect, but preliminary attempts to demonstrate this were unsuccessful. These were made by transferring liver and spleen from rabbits 8 days after the primary injection to noninjected rabbits, and testing the recipients for a secondary response 7 days later. (BBB)

120 THE DISTRIBUTION OF COLONY-FORMING CELLS AMONG SPLEEN COLONIES. L. Siminovitch, E. A. McCulloch, and J. E. Till (Univ. of Toronto). J. Cellular Comp. Physiol., 62: 327-36(Dec. 1963).

Experiments were undertaken to determine whether the cells that are recognized by their ability to form colonies of descendants in the spleens of irradiated mice have the capacity for self-renewal. Recipient mice received 450 Rad of x rays, followed by the injection of 7.5×10^6 nucleated bone marrow cells. Within two hours a further dose of 550 Rad of γ rays was delivered. In this way the recipients received 1000 Rad, sufficient to suppress colony-formation by endogenous colony-forming cells, while the grafted cells received 550 Rad, a dose following which 0.5% of the grafted colony-forming cells retain the ability to form colonies. An adequate number of animals survived from 10 to 14 days, and these mice were found to have spleens with few colonies which were dissected individually from the unfixed spleen. The analysis of spleen colonies showed that such colonies do contain colony-forming cells. The number of colonies that contained colony-forming cells increased rapidly between 10 and 14 days, and the large majority of colonies contained colony-forming cells at 14 days. The sensitivity of the detection method is of the order of 15 to 20%. Thus, the results indicate that probably all or nearly all colonies contain colony-forming cells. Therefore, the colony-forming cell has the capacity for self-renewal, and three properties can be ascribed to the colony-forming cell: capacity for extensive proliferation; related to but not necessarily the same, the capacity for self-renewal; and capacity to give rise to cells with the features of differentiated cells. On this basis, colony-forming cells may be considered to be a class (though not necessarily the only class) of progenitor cells and the spleen colony method is a quantitative method for their detection. (BBB)

121 REVERSION RATE IN CONTINUOUS CULTURES OF AN ESCHERICHIA COLI AUXOTROPH EXPOSED TO GAMMA RAYS. R. J. Munson and Ann Jeffery (Medical Research Council, Harwell, Berks, Eng.). J. Gen. Microbiol., 35: 191-203(May 1964).

Continuous cultures of the tryptophan-requiring strain known as WP2 were continuously exposed to ^{137}Cs γ radiation for several generation times. The frequency of prototrophic revertants increased steadily during irradiation at a rate that was proportional to the radiation dose rate. The change of revertant frequency per unit dose (Rad) was equal to the induced reversion rate per mutable unit. This mutation rate (P) was independent of population density but slightly dependent upon the presence of supplements, such as nutrient broth, to the normal minimal medium with tryptophan. There was a marked dependence of P upon culture temperature, the values at 16, 22, and 37° being 1.2, 2.4, and 3.9×10^{-11}/mutable unit/Rad. It is probable that only a fraction of radioinduced changes in the genetic material that could give rise to phenotypic reversions is actually expressed, this fraction being dependent on the postirradiation temperature. The proportion of the population inactivated by radiation was intentionally kept at 10% or less in order to avoid difficulties in the interpretation of results. Other possible sources of error in P are reviewed. An appendix is included that provides a mathematical analysis of the induction of mutants in bacterial populations exposed to ionizing radiation for very short times (flash doses) and also continuously over many generation times. (BBB)

122 THE EFFECTS OF RADIATION ON THE LONGEVITY OF FEMALE DROSOPHILA SUBOBSCURA. Marion J. Lamb (University Coll., London). J. Insect Physiol., 10: 487-97(1964).

The longevity of adult male and virgin female Drosophila subobscura exposed to single doses of x rays 4 to 8 days after eclosion was investigated. When kept on a maize meal–agar–molasses medium which was replaced every four days, males showed a nearly linear reduction in lifespan with increasing dose; females showed an increase in lifespan after doses of 8,500, 17,000, or 34,000 R. Evidence is given that this increase in longevity is correlated with a decrease in fecundity after irradiation. When females were kept on a medium containing no maize meal but a higher proportion of molasses, or when they were given fresh food every two days instead of four, no large increase in lifespan after irradiation was found. It is suggested that there is an interaction between nutrition, egg production, and longevity, and that x radiation will prolong the lifespan of females only if they are kept in nutritionally suboptimal conditions. (auth)

123 THE EFFECT OF ULTRAVIOLET LIGHT ON PROTEIN AND NUCLEIC ACID SYNTHESIS IN THE EPIDERMIS. Howard P. Baden and Carol Pearlman (Massachusetts General Hospital, Boston). J. Invest. Dermatol., 43: 71-5(July 1964).

Observations on the synthesis of proteins and nucleic acids by the human and guinea pig epidermis following exposure to uv light showed a complex effect of this form of radiant energy on the metabolism of epidermal cells. Following uv irradiation there was an immediate decrease in the incorporation of amino acids and nucleic acid precursors into the epidermis. This was followed within 72 hr by a phase of increased incorporation. Repeated irradiation of the guinea pig with uv light resulted in thickening of the epidermis without a large increase in the capacity to incorporate amino acids into protein. This observation suggested that with chronic exposure there is a balancing of the inhibitory and stimulatory effects of uv light, resulting in a qualitative alteration of cellular metabolism. Increasing daily doses of uv light could not prevent the stimulation of amino acid incorporation that would be expected to result from a single exposure. This was explained in part by increased absorption of light by melanin so that less energy is available to damage the cells. Other mechanisms that may be operating to limit the effectiveness of the incident light are discussed. Data were presented showing that inhibition of the synthetic capacity of

the dermis occurs only when the epidermis is removed prior to irradiation. This suggests that the energy passing through the epidermis is insufficient to produce a direct effect. It was concluded that damage to the epidermis is the primary event which initiates the erythema response. (TCO)

124 MORPHOLOGIC DEMONSTRATION OF RECURRENT TUMOR FOLLOWING X IRRADIATION. HISTOLOGIC STUDY OF IRRADIATED MURINE CHONDROSARCOMA TRANSPLANTS. Richard L. Swarm, Jose N. Correa, J. Robert Andrews, and Eliza Miller (National Cancer Inst., Bethesda, Md.). J. Natl. Cancer Inst., 33: 657-72(Oct. 1964).

The growth of murine chondrosarcoma transplants was interrupted by a single exposure of 2000 R x radiation. Subsequently the tumor resumed growth and grew locally as an invasive tumor. Systematic histologic study of the irradiated tumor revealed a decrease in mitoses and hypertrophy of the tumor chondrocytes. Although many tumor chondrocytes ceased to divide, intercellular matrix formation continued until many chondrocytes died. All the irradiated tumor chondrocytes became rearranged in small lacunar spaces, with fewer cells in each space. Continued matrix formation in the absence of cell division produced an easily recognizable alteration of the histologic pattern. When tumor chondrocytes died and lost their nuclear staining, the persistent intercellular matrix of the irradiated tumor with small empty lacunar spaces served to preserve the location of the dead chondrocytes. Later, 2 to 3 weeks after irradiation, small colonies of recurrent proliferating tumor cells were observed in the irradiated tumor. These colonies had a histologic pattern similar to the unirradiated control tumors. Many small tumor chondrocytes, some in mitoses, were observed in each lacunar space of these recurrent colonies. Growth of these recurrent colonies of tumor chondrocytes accounted for the resumption of growth of the irradiated chondrosarcoma transplant. (auth)

125 ISOLATION OF VARIANT CELL LINES DURING SERIAL TRANSPLANTATION OF HEMATOPOIETIC CELLS DERIVED FROM FETAL LIVER. J. E. Till, E. A. McCulloch, and L. Siminovitch (Univ. of Toronto and Ontario Cancer Inst., Toronto). J. Natl. Cancer Inst., 33: 707-20(Oct. 1964).

Serial transplantation, in irradiated hosts, of cells derived from mouse fetal liver was found in some cases to result in a loss of proliferative capacity by the hematopoietic cells in the graft, as detected by a decrease in their ability to form colonies in the spleens of irradiated mice. In other cases, variant cell types emerged, which exhibited an unusually high efficiency of colony formation. Two such variant cell strains have been isolated, which differ from each other in colony-forming efficiency and in their sensitivity to γ radiation. Some of the properties of these variant strains have been studied; both differ from normal hematopoietic cells and resemble lymphoma cells in that serial transplantation of the variant strains does not result in a decrease in proliferative capacity. In addition, the variant strains form splenic colonies showing no clear evidence of differentiation, and they are able to proliferate in the livers of irradiated adult hosts. They differ from lymphoma cells in that unirradiated, isologous animals receiving grafts of cells of the variant type do not form splenic colonies, nor have they been observed to develop malignant disease. Such unirradiated animals do, however, appear to develop a resistance to subsequent transplants of cells of the variant type. The properties of the variant cells are such that they have a selective advantage over normal hematopoietic cells in the irradiated, but not in the unirradiated, host. (auth)

126 ANEMIA IN MICE EXPOSED TO INFECTION WITH IRRADIATED OR NON-IRRADIATED SCHISTOSOMA MANSONI CERCARIAE. Duane G. Erickson (U. S. Army Tropical Research Medical Lab., San Juan, Puerto Rico). J. Parasitol., 50: 53(June 1964).

Previous experiments demonstrated that Schistosoma mansoni cercariae irradiated with 2500 to 3000 R produced infections in mice in which worm oviposition was absent or greatly diminished. As a possible means of evaluating the role of oviposition in the pathogenesis of schistosomiasis, experiments were designed to compare a low egg-producing bisexual infection resulting from irradiated cercariae, a normal bisexual infection, and a unisexual infection of male worms. Four, 8, and 12 weeks after exposure, 15 mice in each infected group and 10 normal mice were killed. After 16 weeks all survivors were killed. Hemoglobin and hematocrit values as well as numbers and lengths of worms were determined. Egg counts were made on homogenized livers and intestines. After 8 weeks the egg accumulation in mice with normal infections was 15 times that in mice with irradiated-worm infections. Irradiated worms were more numerous than normal ones, but were on the average 1 to 4 mm shorter. No difference in the degree of anemia was detected between animals infected with irradiated male worms. As early as 8 weeks, mice with normal infections were significantly anemic as compared with the three other groups, and all of this group succumbed by 12 weeks. (BBB)

127 CELLULAR AND SUBCELLULAR RESPONSES TO ULTRAVIOLET RADIATION. P. O'B. Montgomery and Rolland C. Reynolds (Univ. of Texas, Dallas and Woodlawn Hospital, Dallas). Lab. Invest., 13: 1243-53(Oct. 1964).

Liver cells in tissue culture were exposed to various doses of ultraviolet light. These studies demonstrated that all of the morphologic structures of the cell respond to ultraviolet irradiation. These include the various membranes such as the cytoplasmic membrane, the endoplasmic reticulum membranes, the mitochondrial membranes, the membranes of the paranuclear body, and the nuclear membrane. The chromatin material of the nucleus and the nucleolus undergo profound alterations as a consequence of ultraviolet irradiation. In view of the multiplicity of the structures and components within the cell which express evidence of ultraviolet damage it is very unlikely that damage to any one structure or component represents the target area of ultraviolet damage. (auth)

128 IMMUNOLOGICAL METHOD OF INCREASING THE SENSITIVITY OF PRIMARY SARCOMAS TO LOCAL IRRADIATION WITH X RAYS. Alexander Haddow and Peter Alexander (Royal Cancer Hospital, London). Lancet, 1: 1327-8(June 1964).

Recently published experiments (Lancet, 1: 452(1964)) on the radiosensitization of tumors are discussed in relation to earlier experiments of a similar nature by Cohen and Cohen (Brit. J. Cancer, 11: 563(1957)). The latter publication dealt with grafted tumors, and the results with mice bearing primary mammary carcinoma were referred to. In one-third of these mice the tumor was cured following a single dose of 4200 R of x rays, and this effect was attributed to the injection of an irradiated autograft. This work principally concerned the influence of tumor-host relation on the radiosensitivity of grafted tumors. The role of irradiated tissue in homograft immunity is well documented, and the experiments were specifically directed to the radiation response of primary tumors where host differences can play no part. The phenomenon reported depends on the presence of antigens peculiar to the tumor, as proved by the fact that only autochthonous tumor tissue is active under these conditions, unlike the situation described by Cohen and Cohen. In the spontaneous mammary carcinoma of the mouse no evidence for tumor-specific antigens has so far been observed, and these tumors appear to differ in this respect from chemically induced tumors. (TCO)

129 USE OF SYNCHRONOUS CELL-CULTURES IN RADIOLOGICAL EXAMINATIONS. Tibor Ganti. Magy. Radiol., No. 2, 110-17(1964).

Cell cultures in which the majority of the cells at any moment is in the same phase of the reproductive cycle (synchronous cultures), offer a possibility of examining the specific processes of cell multiplication and their sensitivity to radiation. A great number of physical and chemical methods was worked out for the synchronization of cell cultures. The effect of the radiation on the mitosis and the

radiation sensitivity in its various stages may be examined in synchronous cultures by means of morphological and biochemical methods. (OTS)

130 HISTOCHEMICAL STUDIES ON THE EFFECTS OF IONIZING RADIATIONS ON THE ENZYME REACTIONS OF THE SKIN OF THE GUINEA PIG. I. ALKALINE AND ACID PHOSPHATASE. L. Bruni and A. Mazza (Università, Pavia, Italy). Minerva Dermatol., 37: 104-8(Mar. 1964). (In Italian)

Experiments were performed to determine the changes induced by ionizing radiations in the enzyme activity of the skin. Four groups of guinea pigs received doses of 500, 1000, 3500 or 5500 R of 60-kv x rays. The results obtained with Gomori's staining method were as follows: alkaline phosphatase activity was increased in the spinous layer, hair follicles, indifferentiated cells of the sebaceous glands, and in the capillaries. It was possible to detect this activity in areas where it is not normally present: the basal layer, papillae, differentiated cells of the sebaceous glands, and internal sheaths of the follicles. Acid phosphatase activity was increased in the spinous and granular layers, internal sheaths of the follicle, indifferentiated cells of the glands, and in the papillae. This activity was present in the external sheath of the follicle, and in the differentiated cells of the sebaceous glands. It is pointed out that the intensity of the reactions is in proportion to the time elapsed since the irradiation. The possibility is suggested that irradiation induces changes in the permeability of the cellular wall or that it destroys the phosphatase activity in the mitochondria. (BBB)

131 RADIATION INJURIES OF THE URINARY TRACT. V. Hoffmann (Universität, Cologne). Muench. Med. Wochschr., 104: 2485-8(1962). (In German)

Discussion is presented on x-ray treatment of female genital carcinomas and the increased incidence of radiation treatment injuries of adjacent pelvic organs and the urinary tract. Injuries of the bladder have been recognized for many years, but alteration of the ureters is a more recent problem. Studies show that in 20 to 25% of groups treated for cervical carcinoma, without recurrence, urological complications appear during the later period of observation in the form of unilateral or bilateral ureteral stenoses, hydronephroses, or the so-called "silent kidney". Almost 10% of all women who die from this type of carcinoma have some sort of complication of the urinary tract, without indication of any carcinoma residue. These injuries may be classified into three groups. The first includes unilateral damage, consisting mainly of a "silent kidney", or extensive hydronephrosis. These cases require close observation. The second group has similar unilateral injuries, but with additional evidence for changes in the rest of the urinary tract, with normally functioning ureters. The third group is characterized by similar bilateral injuries, and it is usually necessary to carry out surgical procedures, such as kidney implantation, to save the lives of these patients. According to present-day experience radiation injuries may be anticipated if the Ra exposure is greater than 6000 mg-hr, or the x-ray dose amounts to 3000 R or more. The changes caused by these types of radiation injuries may consist of edema, fibrotic scarification, perforations, dilated vessels, perivascular cellular infiltration by lymphocytes and plasma cells, and endarteritis. These changes may appear within a few months of the radiation exposure or as late changes appearing after many years. (BBB)

132 OXYGEN EFFECT WITH 14-Mev NEUTRONS. G. J. Neary and J. R. K. Savage (Medical Research Council, Harwell, Berks, Eng.). Nature, 204: 197(Oct. 10, 1964).

Data for effects of 14-Mev neutrons on yields of chromatid-type aberrations in meristematic cells of bean root tips in aerated and anoxic conditions are reported. The dose modification factor for true aberrations was about 1.5 and for nonstaining lesions (gaps) about 1.3. It is reasonably presumed that for other biological effects besides chromosome aberration induction the oxygen factor for 14-Mev neutrons should be small and that, as regards oxygen dependence of effect, 14-Mev neutrons should be almost as suitable for radiotherapy as fast neutrons of lower energy. (P.C.H.)

133 EFFECT OF RADIATION ON PLATELETS IN VITRO. J. Caen, H. Michel, R. Bourdon, H. Vainer, and Jean Bernard (Hospital St. Louis, Paris). Nouvelle Rev. Franc. Hematol., 4: 324-6(Mar.-Apr. 1964). (In French)

Preliminary results are reported of studies on the effects of x irradiation on human platelets in a plasma suspension. The radiation dose was from 50 to 800 Rad. Irradiation did not markedly affect the number of platelets as evidenced by the destruction of not more than 5 to 10% of them. Clot retraction of the platelet-rich plasma also was very little affected by postirradiation. The aggregation capacity of these platelets in the presence of strong or weak concentrations of adenosinediphosphate (ADP), when determined macroscopically, was slightly reduced, whereas the optical density of plasma suspensions of platelets was greatly reduced, the number of platelets being 250,000/mm^3, particularly in the case of weak x-ray doses. On the other hand, the capacity of the irradiated defibrinated plasma (serum) to aggregate platelets from normal plasma rich in platelets was considerably reduced. It would seem that this activity is tied to the release of ADP by the platelets. A decrease in intracellular ADP following a rapid consumption of this nucleotide or permeability effects could account for the decrease in plasma platelet-aggregating activity. (BBB)

134 IRRADIATION AND CONGENITAL MALFORMATIONS. J. W. Millen (Cambridge Univ., Eng.). Practitioner, 191: 143-51(Aug. 1963).

The evidence from the results of animal experiments that irradiation during pregnancy can cause congenital malformations is reviewed. The nature of the malformation depends upon the species of animal, the dosage employed, and the time when it is given. Malformations of the central nervous system are the most readily produced by irradiation in pregnancy but anomalies of the cardiovascular, genito-urinary, and skeletal systems also occur. Although radiation can cause genetic mutations in animals, there is little evidence that these mutations result in an increased incidence of congenital malformations. The teratogenic effects of irradiation in animals are thought to be due to a direct action on the embryo rather than mediated through an effect on the mother. In man, hazards of direct exposure of the fetus to irradiation have been clearly demonstrated by numerous reports of malformed children born to women subjected to therapeutic pelvic irradiation during early pregnancy. Further proof is provided by the consequences of the atomic explosions in Japan. A large number of microcephalic children were born there to women pregnant at the time of exposure, and, surprisingly, microcephaly was the only malformation in which the incidence was directly affected by the radiation exposure. It may be, however, that some of the other effects were masked by the high incidence of fetal death. It is suggested that there is as yet no convincing proof that irradiation produces genetic effects in man. Subject to reasonable precautions, the amount added to the natural background radiation by diagnostic radiology, the wearing of watches with luminous dials, and so forth, is negligible in amount and can be disregarded as a cause of genetic mutations. Although there is some evidence suggestive of an alteration in the sex ratio following massive irradiation, such as might be anticipated if radiation produced a sex-linked lethal mutation, it is pointed out that if genetic mutations do occur as the result of irradiation, any resulting malformations are unlikely to appear for several generations. (BBB)

135 EFFECTS ON DNA SYNTHESIS OF LOCALIZED IRRADIATION OF CELLS IN TISSUE CULTURE BY (i) A u.v. MICROBEAM AND (ii) AN α-PARTICLE MICROBEAM. P. P. Dendy and C. L. Smith (Cambridge Univ., Eng.). Proc. Roy. Soc. (London), Ser. B, 160: 328-44 (Sept. 29, 1964).

The effect on the rate of DNA synthesis of irradiating

parts of single cells in tissue culture with a microbeam of α particles 6 μm in diameter and a microbeam of uv light 3.5 μm in diameter is described. The sites irradiated in both cases were: the nucleolus; the nuclear sap; the cytoplasm; the nutrient medium close to but outside, 5 to 10 μm away from, the cell. Rate of DNA synthesis was measured by means of quantitative ^{3}H-thymidine flash autoradiography. The results were confirmed by measuring the change in total DNA per cell by microspectrophotometric means. The nucleolus appeared to have no specific role in DNA synthesis since inhibition of DNA synthesis by irradiation of the nucleolus did not differ from that produced by irradiation of an equal area of the nuclear sap. Irradiation of either the cytoplasm or the nutrient medium also produced inhibition of DNA synthesis. Equal absorbed amounts of energy per unit volume of either uv light of α-particles produced inhibitions of the same order of magnitude. Inhibition of DNA synthesis in all cases needed several hours to develop fully. It is suggested that the inhibition mechanism may depend on the formation of a radioinduced inhibitory substance which diffuses rapidly throughout the cell. The delay in the full development of the inhibition may arise from the fact that the inhibitory substance acts so as to prevent the replenishment of one of the pools of essential compounds in the DNA synthetic chain. In the light of these comments, other workers' results which support these hypotheses are considered. (auth)

136 THE LATE EFFECTS OF IRRADIATION–CLINICAL ASPECTS: SURGERY OF IRRADIATED TISSUES. E. Stanley Lee (Westminister Hospital, London). Proc. Roy. Soc. Med., 57: 563-4(July 1964).

Some of the problems encountered in the surgical manipulation of tissues previously exposed to radiation are discussed. Surgical operations upon irradiated tissues may be required either as part of a pre-arranged treatment plan, or because of failure to cure, or occasionally to remedy radiation damage. The surgical approach is determined by the type of previous radiotherapy, whether interstitial or external, energy of the rays, field size, dose, dose rate, and the time since treatment. Some examples that illustrate these problems are cited. It was concluded that ablative surgery on even heavily irradiated tissues is feasible, but the operation should be carefully planned, leaving more margin than usual for safety. Extra attention should be paid to the patient's pre-operative condition and to operative details such as hemostasis and asepsis. Reconstructive surgery should, if possible, clear the irradiated tissues widely and defects should be closed by tissue brought in from well outside the treated areas. (TCO)

137 SOME EFFECTS OF IRRADIATION TO THE BOWEL. Kenneth A. Newton (Westminister Hospital, London). Proc. Roy. Soc. Med., 57: 565-9(July 1964).

Lesions developing in several patients following irradiation with the 2-Mev Van de Graaff generator are described. The improvement in survival figures, for cases of teratoma of the testis without clinical evidence of glandular or pulmonary metastases before and after the advent of supervoltage irradiation, demonstrates the effectiveness of the more modern therapy over 250-kv irradiation. An attempt at bone marrow replacement therapy in a case of leukemia is also described. The use of ^{90}Y and ^{198}Au in the treatment of disseminated abdominal malignancy is discussed, and some of the physical characteristics of ^{198}Au and ^{90}Y are compared. Dose factors and pelvic damage associated with the use of ^{60}Co irradiation for cervical cancer are also considered. Complications of such treatment are given. It was concluded that irradiation of a considerable part of the pelvic contents to doses of over 5500 R results in a high incidence of complications referable to the rectum. It is now standard practice when irradiating cervical cancer to use mainly external radiation and to restrict the dose on the 80% isodose contour to 5400 R. As a supplementary measure, two weeks after completion of this external beam therapy, a 50 mg radium tube is inserted into the uterine cavity for 36 hr. This alteration in technique has materially lowered the incidence of complications but not reduced the effectiveness of the therapy. (TCO)

138 NITROGEN BALANCE IN RADIATION CHIMERAS. W. H. McArthur, C. C. Congdon, and A. L. Kretchmar (Knoxville Coll., Tenn.; Oak Ridge National Lab., Tenn.; and Oak Ridge Inst. of Nuclear Studies, Tenn.). Proc. Soc. Exptl. Biol. Med., 117: 171-5(Oct. 1964).

Positive nitrogen balance was observed in mice given 900 R total-body x irradiation and then treated by injection of living bone marrow cells. The average level was about twice that of normal controls for 90 days after irradiation and bone marrow treatment. Mice given isologous cells showed a normal rate of gain in body weight. However, mice given homologous cells failed to gain weight despite the same degree of positive nitrogen balance. (auth)

139 LATE INJURIES DUE TO THOROTRAST. H. Schloegelhofer (Krankenhaus der Barmharzigen Brueder, Vienna). Radiol. Austriaca, 13: 83-8(1962). (In German)

A 62-yr-old man was admitted who had been injected with Thorotrast 22 yr previously. X rays of the thorax were negative, but the liver was enlarged, with extensive opaque areas. The spleen contours were sharply defined, and the organ was contracted. It was diffusely stippled with opacities that were distributed throughout the entire organ. The adjacent lymph nodes also showed extensive deposits of dense, streaked, and reticular material. Postmortem examination of these organs revealed capsular fibrosis of the liver, with spindle like deposits of Th, and enlargement of the capsule of Glisson, where Th deposits were widespread. The ThO_2 was deposited partly in the free state, and partly within macrophages. Deposits of Th were found in cytoplasm and nuclei of the Kupffer cells. The general structure of the liver was intact, but there appeared to be a progressive fibrosis of the parenchyma, where the Th was extensively deposited. In the spleen the borders of the trabeculae contained many Th deposits, but the main mass of Th was situated extracellularly in the form of light grey clumps in the region of the red pulp and the vicinity of the follicles, which were increased in number and size. Finally divided particles of Th were seen in almost all the large reticular cells, and in the thickened hyaline spleen capsule. The patterns of Th deposition were clearly visible in x-ray photographs of sections prepared from these organs. In the lymph nodes Th was deposited in the form of dense particulates and bands. The parenchyma was extensively fibrosed, with dense cytoplasmic inclusions clearly visible. (BBB)

140 THE LIMITS OF SURFACE INJURY IN MOVING RADIATION. R. Seyss (Roentgenabteilung des a. oe. Krankenhauses, Neunkirchen, Austria). Radiol. Clin., 31: 122-6(1962). (In German)

In order to evaluate tolerance limits of the skin to x radiation administered by convergent pendulum radiation, studies were conducted on 40 cases of mammary tumor that were preoperatively irradiated. The tumors were situated subcutaneously at a depth of 3 to 5 cm, and the size of the field was limited to 5 cm at these depths. The lowest total surface doses were between 2500 and 3000 R, fractionated in 16 doses of 200 R or less given over a period of 21 days. This treatment produced erythema and required 40 or 50 days for skin recovery. An exudative skin reaction was produced when 4000 to 5000 R was administered in 20 doses of 240 R or less within 24 days. The skin recovered in 60 to 80 days. When 6000 to 7000 R was given in 30 doses of 250 R or less within 35 days the skin became ulcerated and did not recover until 80 or 125 days after the treatment. In the skin area subjected to the most radiation the dose intensity amounted to from 5 to 20 R/min. The radiation current was adjusted to produce a skin surface dose of 300 R within 9 min. Depending on the focal depth of the tumor dose amounted to 50 to 80 R/min. The radiation extended over areas of 16 to 25 cm^2. The pendulum radius was 50 cm, and its angle was between 90 and 120°. The angle of convergence was ±30°. After healing the site of radiation consisted of a smooth atrophic scar that was compatible with subsequent operation. (BBB)

141 INCORPORATION OF P^{32} INTO THE DEOXYRIBONUCLEIC ACID OF SOME RADIOSENSITIVE ORGANS IN RATS TREATED WITH IODOACETIC ACID AND X-RAYS. M. Quintiliani, M. Boccacci, and L. Tentori (Istituto Superiore di Sanita, Rome). Rend. Ist. Super. Sanita, 23: 1081-94(1960). (In Italian)

The effect of iodoacetic acid and of x rays on the incorporation of ^{32}P into the deoxyribonucleic acid of some radiosensitive organs was studied in the rat. The inhibitory effect of x rays was confirmed. Moreover it was demonstrated that iodoacetic acid, even at sublethal doses, induces a significant decrease of ^{32}P incorporation into DNA of the organs examined. In combined treatment with iodoacetic acid and x rays the inhibition nearly corresponds to the sum of the effects obtained by single treatments. (auth)

142 RADIATION-INDUCED TUMORS OF THE LIVER [IN EXPERIMENTAL ANIMALS]. A. Lacassagne (Foundation Curie, Paris). Rev. Franc. Etudes Clin. Biol., 9: 269-72(1964). (In French)

Hepatic cancers resulting from local and whole-body irradiation with Ra, Th, and ^{198}Au are reviewed. The supplementary effects of chem. carcinogens such as butter yellow are considered. (auth)

143 EYE LESIONS CAUSED BY ATOMIC EXPLOSIONS. A. Lucaciuc-Brambier, N. Baidan, and I. Banacu. Rev. Sanit. Mil., 60: 405-12(May-June 1964).

The literature on eye injuries due to atomic explosions was reviewed, and it was found that lesions can be caused by the shock wave, the light flash, and ionizing radiation. The direct or indirect shock wave is mostly responsible for eyeball contusions, while infrared and visible rays may cause palpebral, corneo-conjunctival and retinal burns, and ionizing radiation may cause radiation disease with resulting changes behind the eyeball (hemorrhages and exudates). A complication can be the appearance of cataracts, especially in young people, after a latent phase of a few months or even years. (OTS)

144 INITIAL BIOPHYSICAL MODIFICATIONS OF THE ORGANISM UNDER THE INFLUENCE OF IONIZING RADIATIONS AND THE PROPHYLACTIC ACTION OF SOME CHEMICALS. I. Berlogea, V. Jucu, D. Barboi, and I. Nichifor. Rev. Sanit. Mil., 60: 413-21(May-June 1964).

A summary is presented of the theories outlined by various scientists with regard to the biophysical action of ionizing radiation on the organism and of several studies relating to the protective effectiveness of β-mercaptoethylamine against lethal doses of radiation. (OTS)

145 DIFFERENT BIOCHEMICAL BEHAVIOR OF TWO STRAINS OF STAPHYLOCOCCUS AUREUS OF DIFFERENT RADIORESISTANCE AFTER IRRADIATION WITH TRITIATED WATER. Giovanni Giovannozzi-Sermanni and Isabfila Cacciari (Università, Rome and Consiglio Nazionale delle Ricerche, Rome). Ric. Sci. Rend., Sez. B, 4: 543-50 (June 1964). (In Italian)

Respiratory quotient, succinic dehydrogenase, succinic thiokinase, catalase, and CoA of two strains of Staphylococcus aureus were analyzed. The resistant strain came from the original strain treated with high doses of tritiated water. The two strains differed remarkably both in biochemical characteristics and in behavior in the presence of tritium β radiations. The radioresistant strain had a lower respiratory quotient after the irradiation, and the succinic dehydrogenase and the succinic thiokinase were not affected; in the first strain they reached lower values. The differences were more evident in the CoA content. The radioresistant strain was richer in CoA, and after irradiation its content increased considerably, unlike that of the first strain. The cystamine, in the presence or absence of radiations, redoubled the CoA content in the first strain, and did not exert any influence in the radioresistant strain. (auth)

146 THE RADIOSENSITIVITY OF DEOXYRIBONUCLEIC ACID (DNA) IN MOUSE THYMUS DEOXYRIBONUCLEOPROTEIN (DNP). Wei Wu. Sheng Wu Hua Hsueh Yu Sheng Wu Wu Li Hsueh Pao, 3: 105-14(1963).

After irradiation with gamma rays (5000 R), purified free DNA (in 1 N NaCl) showed only slight changes in intrinsic viscosity and melting temperature. However, when mouse thymus deoxyribonucleoprotein was irradiated under the same conditions and then immediately extracted with sodium dodecyl sulfate, the intrinsic viscosity and the melting temperature of the isolated DNA were markedly decreased. Treatment of irradiated free DNA with sodium dodecyl sulfate caused a slight decrease in melting temperature and viscosity, but this change was not as marked as that obtained on deproteinized irradiated deoxyribonucleoproteins. It was concluded that, although sodium dodecyl sulfate treatment may intensify radiation damage to DNA, the nucleoprotein is more susceptible to ionizing radiation than the free nucleic acid. A possible role for proteins in the initiation, rather than prevention, of radiation damage to DNA is discussed. (OTS)

147 GROWTH OF X-IRRADIATED MELANOMALIGNOMAS IN TISSUE CULTURE AND TRANSPLANTATION EXPERIMENTS. II. EXPERIMENTS WITH FRACTIONATED IRRADIATION OF HARDING-PASSEY MELANOMA. Arthur Wiskemann, Bernward Rohde, and Joachim Herzberg (Universität, Hamburg). Strahlentherapie, 125: 5-9 (Sept. 1964). (In German)

Harding-Passey-melanomas that were the size of a cherry seed were x-irradiated in vivo with single doses of 1,000 R with 10 mm tissue half value depth. No macroscopic or microscopic changes were observed 24 hours and 8 weeks after irradiation with 5,000 to 12,500 R. Direct radiation damage of the melanocytes could be observed in tissue cultures and during transplantation from animal to animal. In agreement with therapeutic doses necessary for human melanoma, the growth in tissue culture was considerably inhibited 24 hours after fractionated irradiation with 10,000 to 12,500 R; it was almost completely inhibited at higher doses up to 22,500 R. Using the transplantation experiment, the growth rate decreased considerably 24 hours after fractionated irradiation with 5,000 R and 7,500 R and is almost completely ceased after 10,000 R. After 12,500 R a complete standstill was observed. Therefore, the results do not differ significantly from the ones obtained with single irradiation. The importance of attaining full growth of single human and animal melanocytes in the tissue culture in spite of pre-irradiation with large doses is discussed. (auth)

148 EXPERIMENTS ON THE "SEEING" OF FAST ELECTRONS AND ULTRAHARD X RAYS FROM A BETATRON. Benno Markus (Universität, Gottingen, Ger.). Strahlentherapie, 125: 51-60(Sept. 1964). (In German)

Fast electrons of 3.2 and 14.2 Mev as well as ultrahard x rays of 14.2 Mv, produced by a betatron, caused a light impression if a closed dark adapted human eye was irradiated for 0.5 sec with 3×10^{-5} R/sec of electrons and 5×10^{-5} R/sec of x rays. The experiments are described. This dose is about 10 times smaller than that known for conventional x rays, and is considered to be minimal up to now for producing an observable biological effect. The pulse duration of the betatron as well as the production and absorption of Čerenkov radiation in the eye might be responsible for producing this effect with such extremely small doses. The transferred energies as well as the mechanism are discussed. (auth)

149 MITOTIC EFFECT OF IONIZING RADIATION ON BENIGN AND MALIGNANT EPIDERMAL HYPERPLASIA OF THE MOUSE. VII. EFFECT OF A SINGLE CONTACT IRRADIATION ON THE SECOND GROWTH PHASE OF CELLS (CELL DIFFERENTIATION). Kai Setaelae and Eino Erkki Niskanan (Univ. of Helsinki). Strahlentherapie, 125: 109-27(Sept. 1964). (In German)

The mode of response of the second growth facet, cell differentiation, to a $^{90}Sr + ^{90}Y$ contact source, of malignant (provoked by carcinogen 9,10-dimethyl-1,2-benzanthracene) and of benign (provoked by a non-carcinogenic tumor promoter, Tween 60) epidermal hyperplasia in female RA-mice (skin-tumor-resistant mouse strain) is reported. The dose rate was about 1000 rad/9 min. Pretreatment of the backs of the mice with these substances lasted for 10 and 60 days

respectively. The alterations were studied by light and by polarization microscopy, and by a histochemical demonstration of protein-bound –SH groups and of –S–S– bonds. The most important results were that: the effects of irradiation on cell differentiation in the malignant and in the benign states were different in principle, just as those on mitotic activity in these two conditions; the alterations in malignant hyperplasia were characterized by a high-degree radiation susceptibility. This susceptibility manifested itself as severe retrogressive changes in cells and nuclei, changes in intra- and extracellular anisotropy, and a dissociation of –SH groups and –S–S– bonds; on the contrary, benign hyperplasia was characterized by a relatively complete preservation of tissue structures and by a comparatively normal behavior of –SH groups and –S–S– bonds, the alterations being largely transitory. It is emphasized that the cells of malignant and of benign epidermal hyperplasia utilize qualitatively different biosynthetic and regulatory mechanisms, despite the fact that both pathologic states are derived from the same homologous tissue of origin. (auth)

150 INVESTIGATION OF GAS METABOLISM DISTURBANCES IN SUBACUTE RADIATION SICKNESS. Andrzej Danysz, Ryszard Panek, and Henryk Proniewski (Pharmakologische Institut, Medizinische Akademie, Bialystok, Poland). Strahlentherapie, 125: 136-9(Sept. 1964). (In German)

The metabolism of CO_2 and O_2 was studied in white rats during subacute radiation sickness. Total body x-irradiation with 450 and 500 R, respectively, causes a significant disturbance of gas metabolism. The course of the disturbance depended upon the age of the animals. After irradiation, the O_2-consumption as well as the CO_2-excretion were significantly increased in young rats, while it was decreased in adult rats. (auth)

151 LATE RADIATION INJURY OF THE SPINAL CORD. Walther Sinner (Universität, Zurich). Strahlentherapie, 125: 219-38(Oct. 1964). (In German)

Six cases of late radiation myelitis are described; five cases were bone marrow tumors, the other case was an extramedullar and extraspinal primary tumor (esophageal carcinoma). The late radiation damage was confirmed in one case by surgery, and in another case by autopsy. In all cases the current maximal permissable dose was exceeded considerably. Frequency, clinical symptoms, diagnosis, differential diagnosis, and pathological-anatomical fundamentals of the late radiation myelopathia are discussed and important consequences for praxis are pointed out. (auth)

152 CYTOMORPHOLOGICAL INVESTIGATION OF HeLa CELLS AFTER SEPARATE AND COMBINED APPLICATION OF TRENIMON AND COBALT-60 GAMMA RADIATION. Henriette Knoerr-Gaertner and Fritz Dehnhard (Universität, Tübingen, Ger.). Strahlentherapie, 125: 239-57(Oct. 1964). (In German)

Results are reported from cytological studies of the effects of ^{60}Co γ radiation and Trenimon (trisethyleniminobenezoquinone) alone and in various combinations on the growth of HeLa carcinoma cells in culture. Both agents affected growth and reproduction of the cells and a synergistic effect was demonstrated. It was concluded that the effect was caused by different mechanisms. (C.H.)

153 EXPERIMENTAL INVESTIGATION OF THE EFFECTS OF Co^{60} GAMMA RADIATION AND TRENIMON (TRISETHYLENIMINOBENZOQUINONE) ALONE AND IN COMBINATION — ON THE NUCLEUS AND NUCLEOLUS OF CANCER CELLS (STAMM HeLa) IN THE INTERPAHSE IN VITRO. Karl Peters and Gertraude Stein (Universität, Tübingen, Ger.). Strahlentherapie, 125: 258-72(Oct. 1964). (In German)

In in-vitro investigations, significant differences were obtained within the first 24 hours in carcinoma cells (strain HeLa) after exposure to ^{60}Co-γ-rays and to Trenimon as well. Combination of both noxious agents causes a prolonged radiation influence, and an increase in effect could be shown in radiation dose effect experiments. These results are caused by different mechanisms of both agents on the cellular level. This also explains the additive effect when both are used in combination. (auth)

154 RADIOSENSITIVITY OF THE RAT WITH REDUCED BASAL METABOLISM. Heribert Braun, Konrad Ammon, and Guenter Hornung (Universität, Wurzburg, Ger.). Strahlentherapie, 125: 299-304(Oct. 1964). (In German)

Using animal experiments, investigations were made in an attempt to determine the survival time by decreasing the metabolic rate with drugs both before and after x irradiation. Such a procedure might have therapeutic applications. It was shown that rats whose basic metabolism was already lowered at the time of irradiation, showed a greater survival time than non-treated animals. If the decrease in metabolism is continued beyond the time of irradiation or started immediately after irradiation, the mortality is increased. This procedure has no radiation protective effect. The results obtained agree to a great extent with results obtained during hypothermia of animals. (auth)

155 THYROID ACTIVITY AND RADIOSENSITIVITY RELATIONSHIP IN GOLDFISH, CARASSIUS AURATUS L. P. V. Srivastava, H. Etoh, Y. Hyodo, and N. Egami (National Inst. of Radiological Sciences, Chiba, Japan). Strahlentharapie, 125: 305-8(Oct. 1964).

Thyroxine-injected and control goldfish, Carassius auratus L., were irradiated with varying doses of x rays. Administration of a single injection of l-thyroxine causes a significant decrease in the mean survival time and $LD_{50(30)}$ dose. The result demonstrates that in fish also, as in mammals, the thyroid activity is correlated with radiosensitivity. (auth)

156 STRAHLENFORSCHUNG UND STRAHLENBEHANDLUNG. VORTRAGE AUS DEN GEBIETEN DER STRAHLENPHYSIK, STRAHLENBIOLOGIE UND STRAHLENTHERAPIE. BAND III. 42. TAGUNG DER DEUTSCHEN RÖNTGENGESELLSCHAFT IN HAMBURG VOM 16. BIS 19. APRIL 1961. (Radiation Research and Radiation Treatment. Discourses in the Fields of Radiation Physics, Radiation Biology, and Radiotherapy. Volume III. 42 Meeting of the German Roentgen Society, Hamburg 16-19 April, 1961). Hans Meyer and Josef Becker. Strahlentherapie, Sonderbaende, 49: 1-267(1962). Munich and Berlin, Urban Schwarzenberg, 1962.

Papers presented at the 42nd Meeting of the German Roentgen Society on radiation research and radiation treatment are presented. Topics covered by the 30 papers include: radiological diagnosis and therapy of thyroid diseases, radiosensitivity of tumors, clinics and methods for radiation treatment, dosimetry, radiobiology, radiation protection, and medical risks. Separate abstracts were prepared for 18 papers. (M.C.G.)

For abstracts of individual papers see: 157, 158, 159, 160, 161, 162, 163, 210, 211, 212, 266, 267, 268, 269, 270, 271, 272, and 615.

157 VARIABILITY OF RADIATION RESISTANCE OF TUMOR CELLS. Gerhard Schubert (Universität, Hamburg). Strahlentherapie, Sonderbaende, 49: 94-111 (1962). (In German)

The radiation resistance of tumor cells in the clinical-therapeutic region is discussed. The primary radiation resistance of the cancer cells and the developed resistances of malignant tumors are considered. The effects of the structure and function of the reactive cells, the physico-chemical action mechanism of the radiation, and the effects of the supply of cells in the surrounding environment on radiosensitivity are described. Data from various studies are summarized in graphs. Effects of radioprotective compounds are briefly discussed. (M.C.G.)

158 TEST CONDITIONS AND RADIOSENSITIVITY OF TUMOR CELLS. Wolfgang Dittrich (Universität, Hamburg). Strahlentherapie, Sonderbaende, 49: 112-16 (1962). (In German)

Changes in the radiosensitivity of tumor cells after

chronic effects of x radiation or a chronic poison, such as hydrogen peroxide, were studied. Data are presented in graphs. It was found that in the therapeutic dose region sensitivity changes of the tumor cells or irradiated transplants in survival tests can be observed quite well, especially when also due to the chronic physical or chemical poisons. (M.C.G.)

159 BIOCHEMICAL STUDIES OF RADIOSENSITIVITY OF TUMOR CELLS. Heinrich Maass (Universität, Hamburg). Strahlentherapie, Sonderbaende, 49: 117-25 (1962). (In German)

Experiments studying the radiosensitivity of tumor cells are described. On the basis of adenosine triphosphate determination in different organs of rats, it was shown that the damage to the energy metabolism in so-called radiosensitive organs (spleen, thymus) is greater than in the kidneys and liver. The Warburg catalase theory of radiosensitivity of tumor cells was also studied. Results showed that the correctness of the theory must be doubted. For comparison of various biochemical systems relative to their radiosensitivity, DNA synthesis opposite glycolysis and protein synthesis proved to be the most sensitive. (tr-auth)

160 ALTERATION OF PROTEIN STRUCTURE BY X RAYS. Klaus Dose and Boris Rajewsky (Max-Planck-Institut für Biophysik, Frankfurt am Main). Strahlentherapie, Sonderbaende, 49: 215-21(1962). (In German)

By x-ray irradiation of enzymes (for example, lactatdehydrogenase) new (multiple) forms of this enzyme were obtained. This radiochemical-produced modification of the native enzyme had, in part, different physico-chemical, biochemical, and chemical properties from its initial form. It was assumed that these modifications result from changes in the secondary and tertiary protein structure. The necessary radiation doses, at irradiation of 1% protein solutions, amounted to several hundred kr or 10^5 erg/mm^2 or 10^7 erg/ml. (tr-auth)

161 COMPARISON OF MORPHOLOGICAL EFFECTS OF DIFFERENT RADIATION ENERGIES. Herbert Franke and Guenther Pliess (Universität, Hamburg). Strahlentherapie, Sonderbaende, 49: 222-9(1962). (In German)

The radiosensitivity of cells in the incisor base of rat's teeth was reversed proportionally to the degree of their differentiation, thus corresponding to the principle of Bergonie and Tribondeau. For one-time irradiation, a less effect from gamma radiation and a later beginning of the tissue reaction than for conventional x radiation was observed, especially for cell decomposition in the mesenchymic proliferation zone. For protracted gamma irradiation, the relative biological effect for karyorrhexis was lower than for x radiation at dose rates up to 3 R/min. Here the effect was greater than at 12 R/min, while the effect of 6 R/min corresponded about to that at 12 R/min. The effect of 3 R/min gamma radiation was about the same as for 6 R/min x radiation. (tr-auth)

162 EFFECTS OF WHOLE-BODY IRRADIATION ON THE MIDBRAIN-POSTERIOR LOBE SYSTEM. Erwin K. Kratzsch, Hans A. Kuenkel, and Hans H. Wander (Universität, Hamburg). Strahlentherapie, Sonderbaende, 49: 230-3(1962). (In German)

With the help of a special histochemical method, the effect of whole-body irradiation of rats on the midbrain-posterior lobe system was investigated. This system has its origin in the many-celled front hypothalamus. The tests were carried out on rats using 1000 R of 200-kv x radiation at a dose rate of 465 R/min. Three days after irradiation the rats were killed. The effects on the midbrain-posterior lobe system were found to be secondary rather than direct. (M.C.G.)

163 MEDICAL RISK IN RADIOLOGICAL WORK. Heinz Lossen (Universität, Mainz). Strahlentherapie, Sonderbaende, 49: 244-55(1962). (In German)

Cases of occupational injuries in radiological work are considered for the period 1950 to 1959. Symptoms of the illnesses according to medical evaluation are listed. (M.C.G.)

164 MALIGNANT TRANSFORMATION OF BENIGN LARYNGEAL PAPILLOMAS IN CHILDREN AFTER RADIATION THERAPY. Marton Majoros, Kenneth D. Devine, and Edith M. Parkhill (Mayo Clinic, Rochester, Minn.). Surg. Clin. North Am., 43: 1049-61(Aug. 1963).

During a 47-year period, 1914 through 1960, 101 patients up to 16 years of age with microscopically confirmed papillomas of the larynx were seen at the Mayo Clinic. All 101 patients underwent surgical removal and electrocoagulation of papillomas. No evidence of a malignant lesion in the larynx developed in any of the 58 patients who were treated surgically and did not receive irradiation therapy. The papillomas of 43 other patients were irradiated with x rays or Ra or both, in some cases a Ra tube being held directly in contact with the papillomas by the method of direct laryngoscopy. In six (14%) of these 43, clinical and pathologic evidence of malignant transformation of the papillomas occurred years later. Because of the method of application, the exact amount of radiation to the larynx could not be established in any of these six cases, but rough calculation suggested that each patient received large doses, probably several thousand R. All six patients received repeated radiation treatments for two to eight years, and six to 21 years elapsed between the beginning of radiation therapy and the development of malignant change. Several years elapsed between the last treatment with x rays or Ra and the onset of the malignant disease in all cases but one, wherein carcinoma of the larynx developed one year after treatment. Five patients received second courses of irradiation in tumor doses for the malignant lesion with no effect. One of the patients had laryngectomy. Five patients died within two years after a malignant lesion was diagnosed; one died four years later. The tumors were diagnosed as infiltrating squamous cell epitheliomas. No malignant lesions developed in any of the 58 patients who were not treated by means of irradiation. The significance of the six cases in which cancerous lesions developed increases if it is considered that eight of the patients who received radiation died before reaching the age of 30 from causes other than malignancy. It is pointed out that reports of cancer developing at previously irradiated sites are frequent, and that this is the first comparative report on the same benign disease in a relatively large number of patients (58) who did not receive irradiation and a similar number (43) who did receive such therapy. It is concluded that there is no safe amount of radiation for therapeutic purposes in benign diseases or conditions of the neck. Radiation treatment for benign diseases or conditions of the head and neck, especially in children, is strongly condemned. (BBB)

165 VARIABLE MANIFESTATION OF SOME MORPHOLOGICAL MUTATIONS IN JUTE. Rabindra Krishna Basu (Bose Inst., Calcutta). Trans. Bose Res. Inst. (Calcutta), 26: 27-32(Mar. 1963).

Three morphologic mutations induced by irradiation of jute and their behavior in subsequent generations are reported. Seeds of five varieties of jute, namely, Tall Mutant, R. 26, and Chinsura Green of Corchorus olitorius and D. 154 and D. 386 of C. capsularis were irradiated with different doses of x rays and the β rays from ^{32}P and ^{35}S. Self-fertilized seeds of individual plant selections made in X_1, P_1, and S_1 generations were grown to raise X_2, P_2, and S_2 populations. Single plant selections were grown in two field-stations. One mutant described lost negative geotropism and was isolated in a X_3 line of the variety R. 26. The X_1 plant, which was raised following treatment of the seeds with 32,000 R of x rays, and its X_2 progenies were normal phenotypically. One count of the segregation in a single plant progeny grown in the X_3 generation in 1954 gave a total of 76 normal to 24 mutations showing complete loss of negative geotropism of stem, suggesting a monogenic segregation with the mutant as the recessive. During the 1956 season a selected line in the P_2 generation gave 3 plants out of 137 surviving, where the leaves developing from the seventh node appeared spoon-shaped. The P_1 plant was normal and was raised after treatment of seeds of the variety Chinsura Green with 1.80 μC ^{32}P per seed. A P_2 population of the variety

R, 26 had 164 plants of which 4 exhibited extreme deformation of leaves, the plants being characterized by extreme condensation and absence of complete lamina. The rate of growth was remarkably slow and after unfurling about six or seven such deformed leaves, the plants developed signs of degeneration. All attempts to grow these plants under special care proved unsuccessful and all the plants died. Cytologic investigations on roots, collected from the abnormal plants, revealed the chromosome number to be 2n = 14. The mutant plants appeared to be devoid of a pair of satellites but no structural change in chromosomes in these plants could be definitely seen, since the number of healthy roots obtained from these plants were few and critical karyotype analysis was not possible. The results show how mutant characteristics may be greatly modified within a comparatively narrow variation in environment in different years and places within a limited region. Mutations with complete loss of negative geotropism, spoon-shaped leaves, and lack of complete lamina were isolated in X_2 and P_2 generations, but the treated populations raised at two experimental stations from the same selected plants behaved differently for various characters studied. (BBB)

166 SOME MORPHOLOGICAL AND CYTOCHEMICAL CHANGES IN THE CYTOPLASM OF NEUTROPHILIC LEUCOCYTES IN RELATION TO THE REPARATIVE AND DEGENERATIVE PROCESSES OCCURRING ON A RADIATION ACTION. C. S. Sergel', N. K. Sviridov, N. T. Vaganova, and L. M. Omel'yanenko (Ministry of Health, Moscow). Tsitologiya, 6: 30-5(1964). (In Russian)

The pathologic granulosis of neutrophils following x-irradiation can be distinguished in two phases, regenerative or reactive, and degenerative or toxic. In the two cases, the aspects of granulosis are morphologically and cytochemically different. (H.M.G.)

167 A CASE OF CARCINOMA AND SARCOMA IN RADIATION DERMATITIS. Gino Franco Lovo and Natale Cascinelli (Instituto Nazionale per lo Studio e la Cura dei Tumori, Milan). Tumori, 50: 233-8(May-June 1964). (In Italian)

A case history is presented that illustrates the association of carcinoma and sarcoma occurring in an area of skin affected by radiation dermatitis. Twenty-six yr ago, a 22-yr-old woman with pulmonary tuberculosis was subjected to pneumothorax and submitted to repeated x-ray examinations over a two-yr period. One year later she developed dermatitis on her back, which was diagnosed as a radio-induced dermatitis and was not treated at that time. Fifteen years ago she noticed a small bleeding excrescence that responded to local therapy. Thirteen years later, the same type of lesion reappeared, but this time it did not disappear even with topical therapy. Within a few months, the patient developed a second area of dermatitis and was admitted to the hospital. The entire area of dermatitis was surgically removed and histologic examination showed the presence of a squamous cell carcinoma and a spindle cell sarcoma in two different areas. Even though the percentage of malignant transformation of radiodermatitis, according to statistical surveys, varies from 10 to 57%, the association of carcinoma and sarcoma in the same lesion is extremely infrequent. (BBB)

168 INFLUENCE OF IONIZING RADIATION ON GERM CELLS. Feng-tsao Hsu. Tung Wu Hsueh Pao, 12: 16-26(1960).

The effects of whole-body irradiation (600 R) on the germ cells of white mice were determined by histological examination of sections from testes fixed at 5, 30, and 60 minutes and 6 hours after irradiation. In sections of testes fixed 30 or 60 minutes after irradiation the spermatogonia could form chromosomal bridges at anaphase. Growing spermatocytes could undergo pyknosis, nuclear swelling, reversion of pachytene nuclei to a resting state, or formation of syncytia. At meiosis the spermatocytes formed chromosomal bridges with irregularly distributed chromosomal clumps, or exhibited metaphase blocks. Spermatids and developing sperm cells could appear pyknotic, undergo nuclear or cytoplasmic vacuolization, form syncytia, or contain one or more anomalous nuclei. No abnormalities were found in mature sperm, Sertoli cells, or interstitial cells. It is pointed out that changes observed in the various cell stages were extremely variable. (OTS)

169 THE EFFECT OF X-IRRADIATION OF THE PARENT ON THE EMBRYONIC DEVELOPMENT OF GOLDFISH. An-chi Wang and Chun-yuan Wang. Tung Wu Hsueh Pao, 12: 127-30(1960).

When 3-year-old red goldfish were exposed to x irradiation (33.8 R/min for 15 min, then a 10 min rest, and then repeated for 14.5 min) at 25°C there was a subsequent decrease in the rates of fertilization and hatching, and a significant retardation in hatching time. In addition, when both parents were irradiated, the majority of embryos showed malformations, including undifferentiated head or tail, absence of eye or lack of eye pigment, curvature of the vertebrae or tail, and edematous yolk sac and pericardium. The lack of differentiation in the head or eye is thought to be caused by damage to the nervous system, especially the forebrain. Deformation of the caudal region is attributed to incomplete gastrulation, and the edematous changes are thought to be due to maldevelopment of the kidney or of pronephrous tubules. (OTS)

170 EFFECT OF SMALL DOSES OF X-RAY ON THE CEREBRAL CORTEX IN MAMMALS. Wei Shao. Tung Wu Hsueh Pao, 15: 341-7(1963).

Male white mice were irradiated with small doses (10 to 300 R) after which their brains were examined at various time intervals by neurohistologic and cytochemical methods. Dose-related pathological changes (swelling, vacuolation, etc.) in the cells of the cerebral cortex were observed even at doses below 50 R. These changes were reversible in mature animals. Interference with RNA metabolism, demonstrated by accumulation of RNA in the cytoplasm, was observed in the cells of animals irradiated with doses of 50 or 100 R. (OTS)

171 DISTURBANCES OF LENS DEVELOPMENT AS THE CAUSE OF MALFORMATIONS OF THE ANTERIOR OPTIC SEGMENT. Guenther Badtke (Martin-Luther Universität, Halle-Wittenberg, Ger.). Wiss. Z. Martin-Luther-Univ. Halle-Wittenberg, Math. Nat. Reihe, 11: 717-28(June 1962). (In German)

Fourteen eyes from 7 newborn mice of the C57BL/KsJ strain from mothers treated with x rays were studied histologically. The major changes found in the eyes consisted in sum of 13 microphthalmias grossly formed, of which 9 were associated with typically or atypically stratified colobomas and one with an intraocular coloboma cyst, 6 total aphacias, and 6 abstrictions of the lens structure from the upper ectoderm or corneal epithelium. The latter instances were accompanied by microphacias. The cornea showed penetrating defects of the stroma and the Descemet's membrane in the area of the lens syncitia, as well as epithelial defects. In four the lens substance definitely began to empty into the conjunctival sac. In all cases there were coalescences between the malformed iris and the posterior surface of the cornea. For the most part these changes have a secondary significance. The eye of the mouse is normally much less developed at birth, while in man the longer intrauterine development period permits a more complete degenerative or reparative series of events. This may be one of the reasons why the eye defects observed in mice in this study are never seen in full term human newborns. (TCO)

172 PRACTICAL COMBINED METHOD FOR COMPUTING THE MEDIAN LETHAL DOSE (LD_{50}). Jui-yuan Sun. Yao Hsueh Hsueh Pao, 10: 65-74(1963).

A method can be devised for computing the median lethal dose (LD_{50}) if the following experimental proposals are carried out: same number of animals used in each group; dosage given in mathematical progression; reaction conditions corresponding to the distribution of normal conditions; and experimental samples having a reaction rate of 0 to 100%. Through mathematical derivation and calculation of practical samples, the computation process proved much simpler than other methods. Using the simple

method, a regression equation correlating with the log-dose and "Probit" unit can be easily obtained for computing the dosage for any percentage kill without making further corrections. The method is also free from subjective influence. Formulas used are given. (OTS)

173 CARCINOMA OF THE RENAL PELVIS AFTER THOROTRAST PYELOGRAPHY. U. Feine and J. Leonhardt (Universität, Tubingen, Ger.). Z. Krebsforsch., 64: 323-7(1961). (In German)

The case of a patient is described who 15 yr earlier was thought to have renal tuberculosis and received retrograde pyelography with Thorotrast. At that time the right kidney was free from disease and the left kidney was found to have some abnormalities, but no tuberculosis. Fifteen years later the patient again entered the hospital complaining of a kidney ailment on the left side. After removal of the left kidney, pathologic examination showed the presence of cancer cells, and traces of radioactive material remaining from the Thorotrast injection were also found, suggesting a connection between the previous injection of ThO_2 and the cancer. The patient died within a year. Thorotrast was often used for diagnostic purposes between 1930 and 1940 and it was only later discovered to be the cause of malignant tumors and removed from use. The small number of malignant tumors caused by Thorotrast are to be explained by the fact that in many cases the radioactive material may have been eliminated from the body; however, when deformities or irregularities in structure of the kidney exist, the radioactive material may not be totally eliminated, as in the case described. Autoradiography of kidney specimens using a three-month exposure indicated substantial radiation levels present even 15 years after initial injection of ThO_2. At the time of the initial pyelography a chronic inflammation of the renal mucous membranes was found; such inflammation is known to be favorable for a later development of cancer and the administered Thorotrast acting as a foreign body might further worsen the inflammation, the irradiation hastened the process. It is estimated that the accumulated radiation dose caused by such Thorotrast injection may be several thousand R. (BBB)

174 ACTIONS CHIMIQUES ET BIOLOGIQUES DES RADIATIONS. SIXIEME SERIE. (Chemical and Biological Actions of Radiations. Sixth Series). M. Haissinsky, ed. Paris, Masson et Cie Editeurs, 1963. 196p. 65 F.

The four papers prepared for the Sixth Series treat the basic and present problems in radiation chemistry and radiobiology. The subjects are physical methods in radiation chemistry and radiobiology, mechanism of the action of radiation on solid organic compounds, effects of ionizing radiations on molecules in cells, and effects of irradiation on synthesis and loss of DNA. Separate abstracts were prepared. (J.S.R.)

For abstracts of individual sections see: 175, 176, 470, and 838.

175 EFFECTS OF IONIZING RADIATIONS ON MOLECULES IN CELLS. Franklin Hutchinson (Yale Univ., New Haven). p.105-46 of "Actions Chimiques et Biologiques des Radiations. Sixieme Serie." Paris, Masson et Cie Editeurs, 1963.

The immediate effects of ionizing radiations on molecules in cells are described. Inactivation by ionizing radiation of a molecule in cells is ascribed to the sum of two processes, the direct effect and the indirect effect. The inactivation of enzymes in irradiated cells and the actions of ionizing radiation on DNA irradiated in cells are discussed separately. (J.S.R.)

176 EFFECTS OF IRRADIATION ON SYNTHESIS AND LOSS OF DNA. Henry Quastler (Brookhaven National Lab., Upton, N. Y.). p.147-85 of "Actions Chimiques et Biologiques des Radiations. Sixieme Serie." Paris, Masson et Cie Editeurs, 1963.

The principal results obtained in studies on the effects of irradiation on the metabolism of DNA are reviewed and critically analyzed. The possibilities of radiation effects on DNA metabolism are analyzed in a general way and batteries of tests that conform to the analysis given are derived. The physiological importance of radiation effects on DNA synthesis is discussed to indicate that a valid assessment is not yet available. 182 references. (J.S.R.)

177 FALLOUT RADIATION: EFFECTS ON THE SKIN. Robert A. Conard, Eugene P. Cronkite, and Victor P. Bond (Brookhaven National Lab., Upton, N. Y.). p.259-79 of "Atomic Medicine." Baltimore, The Williams and Wilkins Co., 1964. (BNL-6727)

The effects of fallout on human skin are discussed in view of the Marshallese accident. Progression of radiation injuries of the skin is followed from early effects through the latent period, development of gross lesions, chronic effects such as carcinogenesis, and histopathological changes. Methods for treating radioinduced skin injuries and factors influencing severity of skin lesions from fallout are briefly considered. (H.M.G.)

178 CHROMOSOME BREAKAGE IN VITRO. M. A. Bender (Oak Ridge National Lab., Tenn.). p.87-107 of "Mammalian Cytogenetics and Related Problems in Radiobiology." New York, Pergamon Press, 1964.

The following generalizations seem justified in the light of the accumulated data on mammalian somatic chromosome aberrations. Spontaneous aberration rates vary widely in vitro, but appear always to be higher in vitro than in vivo. Spontaneous breakage rates may be influenced by the type of cell in which they are measured, and they are almost certainly influenced by their in vitro environment and history. X-ray-induced aberration rates in mammalian cells in vitro are very similar to those seen in vivo. The induced chromosomal aberration rates in mammalian somatic cells are similar to those observed in the classical systems studied, such as Tradescantia microspores. They are certainly not either very much more sensitive or very much more resistant to radiation damage. (auth)

179 MOLECULAR LOCALIZATION OR RADIATION DAMAGE RELEVANT TO BACTERIAL INACTIVATION. Robert H. Haynes (Univ. of Chicago). p.51-72 of "Physical Processes in Radiation Biology." New York, Academic Press, 1964.

Experiments are discussed that implicate certain of the organic bases in DNA as principle sites of damage from ionizing radiation or radiomimetic alkylating agents. (H.M.G.)

180 ON THE INVOLVEMENT OF DISULFIDE LINKS IN THE RADIATION INACTIVATION OF PROTEINS. Klaus Dose (Max-Planck Inst. for Biophysics, Frankfurt am Main). p.253-66 of "Physical Processes in Radiation Biology." New York, Academic Press, 1964.

SH- and S-S groups were analyzed in x and uv irradiated crystallized egg white lysozyme and insulin. No particularly crucial disulfide bond was evident in uv-inactivated lysozyme, whereas in insulin one disulfide seemed to be crucial in uv-inactivation. X-ray inactivation of lysozyme in solution appeared to be an example of two inactivation mechanisms; the attack on residues of the active site and changes of the general structure of the molecule with the possible involvement of disulfide rupture. (H.M.G.)

181 PHYSICAL COMPONENTS OF RADIATION DAMAGE IN CELLS. R. B. Webb (Argonne National Lab., Ill.). p.267-85 of "Physical Processes in Radiation Biology." New York, Academic Press, 1964.

Methods previously used on spores of Bacillus megaterium in studies of physical and chemical mechanisms in radiation biology were applied to the vegetative bacterium Staphylococcus aureus. Three components of x-ray damage, previously identified in the spore, are shown to be operating in this vegetative system. These are Class I, independent of oxygen either during or after irradiation, Class II, dependent on the presence of oxygen during irradiation and Class III, dependent on the presence of oxygen after irradiation. Class I damage is enhanced by the presence of water and is suppressed by the presence of cysteine or glucose. Class II damage is suppressed by the presence of water. Class III damage is suppressed by the presence of water or nitric

oxide. Although water enhances Class I damage, the overall effect in S. aureus, as in the bacterial spore, is protective. Mechanisms involved in oxygen effects and chemical protection in radiation biology are discussed. (auth)

182 ELECTRONIC ASPECTS OF BIOCHEMISTRY. Proceedings of the International Symposium held at Ravello, Italy, September 16-18, 1963, Sponsored by NATO. Bernard Pullman, ed. New York, Academic Press, 1964. 592p. $20.00. (CONF-266)

Thirty-three papers are included; separate abstracts have been prepared for 5. One of the papers was previously abstracted in NSA, as abstract number 17: 40586. The papers not abstracted separately cover various aspects of biochemistry. (T.F.H.)

For abstracts of individual papers see: 183, 184, 423, 465, and 466.

183 THE CONTRIBUTION OF CHARGE AND ENERGY MIGRATION PHENOMENA TO RADIATION INACTIVATION MECHANISMS IN ENZYMES. L. G. Augenstein and R. Mason (Michigan State Univ., East Lansing and Univ. of Sheffield, Eng.). p.23-8 of "Electronic Aspects of Biochemistry." New York, Academic Press, 1964.

The inactivation of trypsin, catalase, and invertase by u-v light, deuterons, alpha particles, and carbon-nucleus beams (the bombarding particles having energies of 1 to 115 Mev) is studied. Models for the charge and energy migration characteristics in these inactivation reactions are proposed, in attempts to clarify the inactivation mechanisms. (T.F.H.)

184 MOLECULAR ASPECTS OF MUTATIONS. Alberte Pullman (Université, Paris). p.135-52 of "Electronic Aspects of Biochemistry." New York, Academic Press, 1964.

Mutagenesis by u-v radiation, ionizing radiation, and chemical agents, as well as spontaneous mutations, is studied. The interpretation of the physico-chemical phenomena involved in mutagenesis at the electronic level is discussed. (T.F.H.)

185 SOME EFFECTS OF GAS-PLASMA RADIATION ON SEEDS. C. Alan Pettibone (Washington State Univ., Pullman). 15p. (CONF-646-2)

From American Society of Agricultural Engineers 1964 Annual Meeting, Fort Collins, Colo, June 1964.

The effects of gas-plasma seed irradiation on wheat, alfalfa, red clover, sweetclover, beans, and several grass varieties are discussed. The treatment was effective in reducing hard-seed percentages in seed lots of alfalfa, red clover, and sweetclover and beans. The cooking time of irradiated dry bean samples was reduced slightly. Germination tests conducted on several seed lots of irradiated dormant grass seed are discussed. The treatment increased both germination rate and total germination of Newport Kentucky bluegrass. The radiation reduced the seedling height of greenhouse-grown wheat plants. This height reduction was not observed in plants grown to maturity in field plots. (auth)

Radiation Effects Therapy and Countermeasures

186 (HW-81746(p.3.111-13)) ATTEMPTED CHEMICAL PROTECTION OF RADISH SEEDS FROM RADIATION DAMAGE. D. R. Kalkwarf (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Erioglaucine, which reacts rapidly with hydroxyl radicals, was tested as a protective agent in radish seeds subjected to radiation damage. No protective effect was observed in seed germination trials, although factors that may have masked such an observation were noted. (auth)

187 (HW-81746(p.3.124-5)) AN EFFECT OF POLYELECTROLYTES ON HEMOLYSIS OF IRRADIATED ALLIGATOR RED BLOOD CELLS. W. B. Silker (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

An inhibition of hemolysis of alligator red blood cells following irradiation was observed in solutions containing an anionic polyelectrolyte. (auth)

188 (JPRS-26842) CURRENT CONCEPTS OF MECHANISMS OF THE PROTECTIVE EFFECT OF CHEMICAL COMPOUNDS AGAINST RADIATION. V. A. Baraboy. Translated from Usp. Sovrem. Biol., 58: 52-73 (July-Aug. 1964). 40p. (TT-64-51099). $2.00(OTS).

Current concepts of reaction mechanisms involved in the protective effects of chemical compounds against radiation injuries are reviewed. Reactions involving both single cells and entire organisms are discussed. The chemical structure and pharmacological properties of chemical compounds that have been found to give some protection against radiation injuries in animals are summarized. 255 references. (C.H.)

189 RESPONSES TO Na^+, K^+, ATROPINE, AND ADRENALINE OF MELANOPHORES INDUCED BY X-IRRADIATION IN THE FIN OF THE GOLDFISH, CARASSIUS AURATUS. Hisami Etoh and Nobuo Egami (National Inst. of Radiological Sciences, Chiba, Japan). Annotationes Zool. Japon., 36: 133-9(Sept. 1963).

Within seven days after irradiation of the whole body with 1000 to 8000 R of x rays, many melanocytes were produced in the fins and the skin of xanthic goldfish, Carassius auratus. The melanocytes became gradually increased in number and in size, and eventually developed into melanophores, the first melanophores being encountered at 16 days after irradiation. Comparative studies were made on responses of the x-ray induced melanophores of the goldfish and of normal melanophores in the wild funa fish, C. carassius, to K and Na ions and adrenaline and atropine, by recording photoelectrically the behavior of the melanophores in split preparations isolated from the caudal fins. When exposed to the ions or drugs, melanocytes produced in the irradiated fish could not move melanin granules in the cytoplasm. In some newly formed melanophores, atropine caused dispersion of melanin granules whilst adrenaline caused concentration, but Na and K ions failed to induce any movement of the granules. In well developed melanophores in irradiated goldfish three weeks or more after irradiation, Na^+ and atropine induced dispersion of melanin granules, while K^+ and adrenaline caused concentration of the granules. These melanophores were no longer distinguishable in responses to the drugs and ions from those normally found in the funa fish. (auth)

190 THE TREATMENT OF LETHAL RADIATION DAMAGE WITH COBALAMIN. Gunther Barth and Herbert Graebner (Universität, Giessen, Ger.). Arzneimittel-Forsch., 14: 665-8(June 1964). (In German)

Effects of vitamin B_{12} on survival time and body weight after lethal whole-body radiation of homozygous and heterozygous strains of female mice were studied. The radiation dose amounted to 650 R of x ray administered so that the 100% isodose line was at the center of the animals' bodies. The cobalamin acetate was administered in physiological saline at the time the animals were irradiated. Its effectiveness was measured by survival time and body weight changes. The doses of cobalamin administered were 1, 2, 5, 10, and 20 μg intraperitoneally. The highest of these dose levels was not necessarily the most effective. When 12 to 13 irradiated animals were caged together, 98% of them survived at least 40 days after a 5-μg dose of cobalamin. When the animals were caged singly, 100% survived for 30 days after irradiation, even though only 1 μg of cobalamin was administered. In the untreated irradiated control animals the survival was only 14%, regardless of whether the animals were caged singly or in groups of 12 or 13. Weight losses were observed in both the treated and the control groups within 5 days after the radiation exposure, but it was much less severe in the cobalamin-treated animals than in the untreated controls. After the initial weight loss, the average weight of the treated animals in-

creased more than the average weight of the control animals that survived for 30 days. The results suggested that cobalamin treatment of irradiated animals resulted in a definitely improved survival after exposure to a lethal dose of x radiation. The fact that the greatest effect of cobalamin was found when it was used at the lower ranges of dosage indicates that it is not possible to transfer the results of this study directly to applications of this type of medication to humans. Instead, it will be necessary to establish a dosage range for humans which will be most effective for treatment of radiation injury. The finding that a lower dosage of cobalamin was effective when the animals were caged separately instead of in groups is in agreement with the observation that has been made in man that complete rest is important for the success of medical therapy of radiation pathology. (BBB)

191 MARROW TRANSPLANTATION: SPLEEN COLONIZATION AS A MODEL FOR THE STUDY OF THE QUANTITATIVE EFFECT OF FREEZING ON THE BASIC REPOPULATING UNIT. J. P. Lewis and F. E. Trobaugh, Jr. (Presbyterian-St. Luke's Hospital, Chicago). Bibliotheca Haematol., No. 19, 274-80(1964).

Studies were directed at comparing lethally irradiated mouse survival to the number of fresh marrow cells transplanted. Twelve-week-old CAF_1 mice were heavily irradiated and injected with marrow cells. Ten days after injection, the mice were sacrificed, the spleens removed and fixed. The number of colonies of marrow cells formed was linearly related to the number of hematopoietic cells injected. Each colony contained a central core of nucleated red cells with satellite clusters of white cell precursors and megakaryocytes. Since it seems that it is the pluripotential cell or basic repopulating unit that seeds in the host animal and grants protection to the marrow-depleted animal, the number of these colonies should be directly related to the transplantation value of the marrow suspension. This model should be applicable to quantitating the effects of freezing and thawing on a suspension of marrow cells. To test this, a suspension of marrow cells was divided into two equal parts. The first part was injected immediately into irradiated isologous animals. The second part was frozen, stored, and at a later date thawed and injected into similarly irradiated isologous animals. Comparison of the number of colonies produced in the animals receiving the fresh cells to the number of colonies produced in the animals receiving the frozen cells should give an estimate of the repopulating potential of the two marrow suspensions. Also described are experiments to study the effects of a standard procedure of freezing and thawing on the repopulating potential of mouse marrow. (TCO)

192 ERYTHROPOIETIC RECOVERY IN MICE PROTECTED WITH FRESH AND FROZEN BONE MARROW. I. A. Iossifides, L. Gutzait, M. Brand, and L. M. Tocantins (Jefferson Medical Coll., Philadelphia). Bibliotheca Haematol., No. 19, 281-6(1964).

Patterns of erythroid recovery were studied through the 24-hr ^{59}Fe utilization method in mice lethally x irradiated and protected with fresh and frozen bone marrow in both isologous and homologous combinations. C_3H/He male mice 16 to 20 weeks old served as isologous bone marrow donors while strain A male mice were used as donors in the homologous combinations. Bone marrow suspensions were prepared in a buffered EDTA solution containing antibiotics. A standard protective dose of 10×10^6 nucleated cells was used throughout the experiments and it was administered within two hours following 900-R exposure to x rays. The 24-hr radioiron uptake was determined in lethally x-irradiated mice between days two and 20 following protection. The results showed that under the experimental conditions described the erythropoietic activity is restored to normal levels between days 4 and 7 when fresh marrow is infused, and between days 5 and 8, when preserved cells are used. There was some evidence that freezing-thawing with dimethylsulfoxide as a preservative destroys some basic erythroid marrow elements, and as a result erythropoietic recovery is delayed for about 24 hr. This selective elimination of marrow elements by freezing can also explain the low functional capacity demonstrated by the preserved marrow in in vitro viability tests. It is possible that in short-term culture studies the cells capable of restoring erythropoiesis in x-irradiated mice are few, and only incorporate small amounts of the radioactive tracer. (TCO)

193 RESTORATION OF HEMOPOIETIC FUNCTION IN THE IRRADIATED MOUSE BY MEANS OF ALLOGENIC BONE-MARROW GRAFTS FROM SEVERAL DONORS OF DIFFERENT STRAINS. G. Mathe, J. L. Amiel, M. Matsukura, and A. M. Mery (Hôpital Saint-Louis, Paris). Brit. J. Haematol., 10: 257-63(Apr. 1964).

In mice subjected to lethal whole-body irradiation a comparison was made of the result of bone-marrow grafting by a mixture from several genetically different donors with that obtained by a graft from a single donor. The results were evaluated on the basis of the three criteria: restoration of bone marrow, occurrence of secondary syndromes, and production of hemopoietic chimerisms of sufficiently long duration. F_1 mice (CBA × $C_{57}Br$), aged ~three months, were subjected to whole-body x irradiation with 950 rad. This dose kills 82% of F_1 hybrids (CBA × $C_{57}Br$) irradiated and not treated before the 20th day after the irradiation. The results showed that the hematologic restoration of mice irradiated with a fetal dose can be brought about with a mixture of bone marrow cells from genetically different donors. The results obtained on the restoration of the bone marrow of the hosts and on the secondary syndromes evoked by this transplantation are for a given number of cells intermediate between those obtained with marrow cells from the genetically optimal donor and with cells from the least suitable donor. These hemopoietic grafts originating from a pool of genetically different allogenic donors may give rise to the development of long-term hemopoietic chimeras, the existence of which is demonstrated by persistence of the skin grafts. These persistent chimeras are even, for a given number of cells, more frequent than in the groups restored with cells from a single donor. As this tolerance manifests itself specifically for the two donors that are genetically closest to the host, it is concluded that a secondary process of selection occurs in favor of the most suitable allogenic hemopoietic graft. These experimental results are considered in view to the possibilities of bone-marrow grafting in human patients. At the present time it is not possible to select from among several possible donors of tissues and organs for man the one closest to the host, since the relation of histocompatibility can apparently not be determined directly on the basis of the erythrocyte or the leucocyte antigens. The use of a mixture from several donors would make it possible to avoid the risk of failure of the restoration of the bone marrow and of a severe secondary syndrome due to choice of a single unsuitable donor; with this method persistent hemopoietic chimeras are brought about and it even appears that in certain cases the hemopoietic tissue of the host is completely suppressed. Thus, such mixed grafts appear to have the qualities required for attempts to treat human leukemia by total irradiation followed by transplantation of allogenic bone marrow. (BBB)

194 A HEMATOLOGIST'S APPROACH TO MODERN GRAFTING PROBLEMS. G. Mathe and J. L. Amiel (Institut Gustave Roussy, Villejuif, France). Brit. Med. J., 2: 527-30(Aug. 29, 1964).

An analysis is presented of the results of bone marrow replacement therapy in 23 subjects exposed to high-dosage whole-body irradiation. Some problems encountered in marrow grafting are discussed and possible means for ameliorating the secondary syndrome suggested. Because it is particularly severe in man, this syndrome constitutes the principal obstacle to the routine use of allogenic hemopoietic cell grafts. It has been confirmed, in mice, that treatment with antimitotics such as amethopterin and cyclophosphamide is effective, and the importance in man of symptomatic treatment (maintenance of aseptic conditions, antibiotics, ϵ-aminocaproic acid, adrenocortical steroids) is emphasized. It was observed that preservation of hemopoietic cells in Tyrode solution for two hours at 37°C con-

siderably reduced the frequency of secondary syndromes without appreciably reducing that of myeloid restoration. Analysis of the phenomenon showed that immunologically competent cells are very sensitive to this mode of preservation, which does not affect the myeloid tissue cells. However, an attempt to use this in a human bone-marrow application failed. The use of multiple donors has also proved an aid in preventing a secondary syndrome. In experiments in mice, after whole-body x irradiation at a lethal dosage and injection of bone marrow from five donors, the frequency of secondary syndromes for a given number of cells administered was much lower than that in controls transfused only from the most remote donor. (TCO)

195 A CONTRIBUTION TO THE TREATMENT OF X-RAY ULCERS. K. Kratochvil (Steiermaerkische Gebietskrankenkasse, Graz). Chirurg, 33: 517-20(Nov. 1962). (In German)

Radiogenic skin injuries appear as early or late ulcers. Early ulcers are rare, because present dosimetric procedures permit dosages to be measured exactly. They appear from 3 days to 8 months after irradiation, depending on the dose given. Late ulcers appear many years after the causal radiation. Perhaps 30% of all patients with late ulcers may develop carcinomas, if they live long enough. Characteristics of radiation injuries are discussed. Four cases are described of patients from whom, after preliminary improvement of their nutritional status, radiation ulcers were excised and the area repaired by skin flaps. The patients recovered enough to carry on normal occupations, without recurrence of the ulcers for the past 6 yr. (TCO)

196 THE EFFECT OF STREPTOMYCIN IN PREVENTING RADIATION DAMAGE TO THE CHROMOSOMES OF MAMMALIAN GERM CELLS. Wei Shao, Tu-kung Wang, and Han Chang. K'o Hsueh T'ung Pao, No. 2, 169-70 (1964).

Examination of the germ cells of adult male mice exposed to whole-body x irradiation (150 R in 5 min) 16 and 38 hr earlier revealed 10.40 and 9.18% abnormal chromosomes, respectively. Prior treatment of the irradiated mice with streptomycin (0.5–5.0 mg i.p. 8 hr before irradiation) reduced the percent of abnormal chromosomes to 3.76–6.51 at 16 hr and 4.62–6.35 at 38 hr, the best protection being provided by the lowest amounts of streptomycin. In order to check this last phenomenon, nonirradiated mice were given the same dosage of streptomycin; histological examination of the germ cells 24 and 46 hr after treatment revealed a slight increase in the percent of abnormal chromosomes (from 0.13 in controls to 2.10 46 hr after administration of 5.0 mg). (OTS)

197 PROTECTION OF IRRADIATED MICE AGAINST PSEUDOMONAS AERUGINOSA AND ITS CONTROL IN A CONVENTIONAL COLONY. H. Wolf, W. Stenback, Patricia Taylor, J. Pinero, C. Graber, and J. J. Trentin (Baylor Univ., Houston, Tex.). Lab. Animal Care, 14: 332-3(Aug. 1964).

The appearance of P. aeruginosa in the gastrointestinal flora of a colony of mice used for irradiation and bone marrow transplantation studies resulted in premature deaths (three to 8 days postirradiation) with Pseudomonas septicemia. Protective results of active and passive immunization of mice to be irradiated were unsuccessful. Of many antibiotics tested in vitro and in vivo, the most satisfactory protection was achieved with parenteral administration of a combination of gentamicin (Garymycin sulfate), 40 mg/kg body wt, and streptomycin, 160 mg/kg. Radiation experiments with Pseudomonas-infected mice were made possible by injecting these antibiotics from two days before until 14 days after day of irradiation. Examinations of irradiated and nonirradiated mice were carried out to determine Pseudomonas-infected sites in the body. Extensive revision of work procedures and sanitation controls in the mouse colony reduced, but did not eliminate, the enzootic infection. The number of pseudomonads present in the irradiated mouse can be a critical factor in time of death, or in survival in the case of bone marrow-treated animals. (BBB)

198 ON THE REPARATIVE ACTIVITY OF AN OINTMENT CONTAINING MENTHYL PANTOTHENATE IN HUMAN SKIN ULCERATIONS. V. Ciaula (Università, Bari, Italy). Minerva Dermatol., 38: 271-5(Aug. 1963). (In Italian)

The activity of a menthyl pantothenate ointment in promoting healing was studied in 30 patients with chronic ulcers of the skin that failed to improve with the conventional therapy. The ointment, Pantomen, was composed of 3% menthyl pantothenate, 2% vitamin F, cod liver oil, and 0.01% phenyl mercuric acetate. The group included cases of indolent ulcers of the leg, ulcerations produced by radiation, decubital and trophic ulcers, and eczematous dermatitis. The duration of the lesions varied from a few days to 12 yr. Four cases failed to improve, three showed marked improvement, and 23 showed complete healing. Cure was obtained within a period of 4 to 25 days and on an average of 17 days. The ointment was well-tolerated even in the cases in which the therapy lasted for 25 days. In the patients that showed abnormal growth of the tissues or infection it was necessary to use additional treatment to correct these conditions because the menthyl pantothenate ointment only stimulated tissue growth and local repair. (BBB)

199 PROTECTION WITH 2-β-AMINOETHYLISOTHIOUREA, GLUTATHIONE AND SEROTONIN OF MICE AGAINST WHOLE-BODY IRRADIATION. J. R. Maisin (Centre d'Etude de l'Energie Nucléaire, Mol, Belg.). Nature, 204: 196-7(Oct. 10, 1964).

Results are reported on the survival of mice treated with glutathione, AET, and serotonin, given separately or in combination, prior to exposure to a supralethal dose (1350, 1800, or 2000 R) of x radiation. After a dose of 1350 R all the nontreated mice as well as the mice treated with glutathione died within 8 days. Ten percent of the mice treated with serotonin and 20% of those treated with AET survived after 30 days. Forty percent of the mice treated with AET + glutathione and 70% of those treated with AET + serotonin were still alive after 30 days, whereas 90% of the mice treated with AET, glutathione, and serotonin survived the same period of time. The combined treatment with serotonin + glutathione was less effective than the protection offered by the combined treatment with AET + serotonin or AET + glutathione. The results also showed that some protection to mice subjected to whole-body x irradiation at 2000 R was offered by the combined treatment of all three. (P.C.H.)

200 RADIOPROTECTIVE EFFECTS OF PYRIDOXAL-5-PHOSPHATE. H.-A. Ladner and R. von Duesterlho (Universität, Freiburg i. B.). Naturwissenschaften, 51: 407-8(1964). (In German)

The radioprotective effects of pyridoxal-5-phosphate were tested in male rats exposed to 955-R whole-body irradiation. The survival rate was determined as a function of the drug dose, the time between administration and irradiation, and the type of administration. The results showed that an intraperitoneal injection protected the rats against a whole-body irradiation 5 min later. Extension of the time factor to 30 min decreased the protective effect. Intravenous injections increased the survival rate from 4 to 70%. (J.S.R.)

201 RELATION OF BLOOD GROUP GENOTYPES TO THERAPEUTIC EFFECTIVENESS OF BONE MARROW TRANSPLANTS FOLLOWING X-IRRADIATION. B. B. Bailey, R. C. Fanguy, and J. H. Quisenberry (Texas Agricultural and Mechanical Univ., College Station). Proc. Soc. Exptl. Biol. Med., 117: 209-15(Oct. 1964).

Chicks of known blood group genotype and parentage were subjected to 1800 R of discontinuous x irradiation when approximately 21 days of age. Immediately following irradiation hosts received intravenous injections of bone marrow homogenate obtained from sacrificed donors having various degrees of blood group genotype relationship with the respective hosts. Thirty day post-irradiation mortality of hosts receiving transplants from donors of a different breed or of the same breed but of incompatible A, B, C, and D blood group genotype was essentially the same as

the irradiated controls receiving no bone marrow transplants. These groups averaged 7.3% survival as opposed to 66.3% survival for hosts receiving transplants from donors of identical blood type. When donor and host were full-sibs in addition to having compatible blood type the survival rate increased to 83.8%. Incompatibility of donor and host at the A, C, and D blood group loci resulted in essentially the same levels of mortality; the average being 42.42%. This is in contrast to 86.67% mortality of hosts having donors of incompatible B system genotype. Hemagglutination tests showed the majority of the hosts to be circulating red cells of the host-type by 10 days post-irradiation, a mixture of donor and host types from 15 days through 60 days post-irradiation, and host-type by 70 days post-irradiation. These tests also showed 38.5% of the hosts to be circulating only donor-type cells by 40 days post-irradiation and one individual still exhibited only donor-type cells at 80 days. Donor-type cells were detected in 100% of the hosts having donors of incompatible A, C, or D blood type. Where incompatibility at the B locus was involved, only one host was found to be circulating donor-type cells during the post-irradiation period. (auth)

202 THE CURRENT STATE OF THERAPY OF SKIN REACTIONS AFTER RADIATION TREATMENT. W. Hellriegel (Universität, Frankfurt am Main). Radiologe, 2: 300-4(Aug. 1962). (In German)

At present no medication is known that can prevent reactions of the skin and mucosa to radiation. However, general prophylactic procedures can be used to reduce their severity. Irradiated skin should be kept under conditions as normal as possible. Free exposure to air is advantageous. The patient should have much rest, no manual labor, mild exercise, and a diet high in proteins, vitamins, and minerals. In the area irradiated, pressure constriction, warmth, sunlight, and uv radiation should be avoided. Bandages should be loose. The scattered radiation at the edge of a radiation field is sufficient to cause dermatitis or an allergic reaction if an adhesive bandage is used. Any additional irritation of the skin will cause radiation dermatitis. Because edema, whether it is interepithelial in the epidermis or interstitial in the corium and subcutis, is a factor in skin inflammation, a hygroscopic powder can be used to reduce the edema fluid. Only powders with the smallest particles, applied with an absorbent cotton compress, should be used, to avoid microabrasions of the skin. Powders that contain antiphlogistic substances like azulene have the advantage of reducing dermatitis. Salves often reduce absorption of secretions, increase dermatitis, or have incompatible bases, including even the so-called nonirritating and neutral silicone-base salves. Salves are useful only for mucosal areas, such as eyelids, nostrils, lips, or genitoanal areas. Bactericidal salves are suitable here. Vitamin A (150,000 to 200,000 units daily) for epithelization, vitamin C (1 g) for protection against infection and improved resistance, and vitamin B_{12} (100 μg daily) with vitamins P and K for capillary formation and increased tissue vascularity, are desirable. Good results from oxyphenylbutazone and prednisolone have been reported after megavolt therapy or conventional x radiation. Inflammation and exudation are markedly reduced or heal rapidly. (BBB)

203 NEW MERCAPTOAMINES AS RADIOPROTECTIVE AGENTS. Laura de Bellis, Anna Farina, Giuseppe A. Procelli, and Maria Luisa Stein (Università, Rome and Centro Nazionale per la Chimica del Farmaco, Rome). Ric. Sci. Rend., Sez. B, 4: 589-96(June 1964). (In Italian)

The synthesis, through 1,2-bis (2′-phenylthiazolidin-4′-one-3′)-ethane, of N,N′-dibenzyl-N,N′-dimercaptoethylethylendiamine is described. The structure to be assigned to the two forms obtained of the bis-thiazolidone is discussed. A new bis-isothiuronium compound and the related dimercaptan are also described. The results of tests conducted in order to establish their radioprotective activity in vitro on chicken embryo cells are given. (auth)

204 TRANSPLANTATION OF HEMATOPOIETIC CELLS. H. E. M. Kay (Royal Marsden Hospital, London). Sci. Basis Med. Ann. Rev. 327-44(1962).

Restoration of bone marrow function, especially after whole-body irradiation, by injection of marrow and spleen cells is discussed. For therapeutic purposes whole-body irradiation is given in doses high enough to damage the reticulo-endothelial system so that primary immune responses are either abolished or very considerably attenuated and delayed. Such a dose is normally lethal but it may allow a life-saving allograft of bone marrow or of hemopoietic cells from the fetal liver or spleen to establish itself. The actual outcome of any attempt of this sort is determined by several variables, two of the main factors being considered are the dose of donor cells and the irradiation dose. Possible reaction mechanisms involved are discussed. (C.H.)

205 CHANGES IN THE EFFECT OF SODIUM PENTOBARBITAL IN IRRADIATED ANIMALS. Ming-chih Hsieh and Chen-yu Sung (Inst. of Materia Medica, Peking). Shing Li Hsueh Pao, 26: 339-46(Dec. 1963). (In Chinese)

The effect of sodium pentobarbital in mice (sleeping time) and rabbits (EEG) at different periods after a single total-body irradiation at a dose of 500 R or 1000 R was investigated. The rate of metabolism of pentobarbital in these irradiated animals was also determined. At the early and the recovery stages (1 to 5 days and 16 to 30 days after 500 R x-irradiation), the sodium pentobarbital (60 mg/kg i.p.) sleeping time in mice was not affected. However, at the height of radiation sickness, 5 to 15 days after irradiation, the sleeping time was significantly prolonged. Administration of sodium pentobarbital (20 mg/kg i.v.) to rabbits with severe radiation injury caused by exposing to a single total-body dose of 1000 R of γ-irradiation (^{60}Co), produced a deep depressing effect as indicated by changes in the EEG, while prior to irradiation the same dose of pentobarbital caused only negligible depression. The rate of disappearance of the injected pentobarbital from x-irradiated skinned whole mice was significantly slower than that of the control animals. This observation was substantiated by the rate of biotransformation of the drug in vitro by liver slices from x-irradiated mice. When a comparison was made between the concentrations of the drugs in irradiated and control mice at the wake-up time, it was found that the irradiated animals woke up at a total body level significantly lower than the controls. It would appear that the irradiated animals were more sensitive to the drug. These results would suggest that both the decrease in the rate of metabolism of the drug and the increase of the sensitivity of the central nervous system to the drug contributed to the change of the response of the irradiated animals to pentobarbital. (auth)

206 AET PROTECTIVE EFFECTS IN RADIOINDUCED DOMINANT LETHAL MUTATIONS IN THE MOUSE. Udo H. Ehling (Institut fur Strahlenschutzforschung, Neuherberg, Ger.). Strahlentherapie, 125: 128-35(Sept. 1964). (In German)

Hybrid F_1 male mice (101 × C3H), 10 to 12 weeks old, were given an intraperitoneal injection of 9 mg S,2-aminoethylisothiuronium BrHBr (AET) or an equal volume of 0.9% NaCl. Time between injection and whole-body x-irradiation with 600 R, 500 + 500 R, or 1000 R was 15 to 20 minutes, except one experiment where the time was 25 to 40 minutes. After treatment each male was caged separately with two hybrid females 10 to 12 weeks old. The males were transferred to a fresh set of females 7 and 14 days after irradiation. The uterine contents of fertilized females were examined $13\frac{1}{2}$ to $16\frac{1}{2}$ days post conception. No protection against radiation-induced dominant lethals was observed in spermatozoa. More data are needed to evaluate the response of late spermatids. Protective action of AET was observed in early spermatids, where the mean number of living embryos per female was increased from 1.1 ± 0.1 in the group receiving NaCl + 600 R to 2.6 ± 0.2 in the group receiving AET + 600 R. The bases of the protective action of AET and the effect of the cell stage are discussed. (auth)

207 INVESTIGATIONS ON BIOLOGICAL RADIATION PROTECTION. 56. REPORT: QUANTITATIVE RESULTS WITH RADIATION PROTECTION BY HISTA-

MINE. Ruprecht Koch (Universität, Freiburg i. B.). Strahlentherapie, 125: 140-4(Sept. 1964). (In German)

The following results were obtained with total body irradiation of male mice with increasing radiation doses (810, 950, and 1000 R) and increasing histamine doses (0.5, 1.0, 2.0, and 5.0 mg histamine base/20 mg mouse) for each radiation dose. Keeping the radiation dose constant, all histamine doses exhibited the same protective effect. Histamine protection was the same for all radiation doses used. Thus, there is a significant difference between a radical scavenging protective substance, such as cysteamine, and a pharmacodynamically effective substance, such as histamine, which decreases the oxygen partial pressure in the tissue. (auth)

208 INVESTIGATION OF A BIOLOGICAL RADIATION PROTECTOR. LVII. THE EFFECT OF VEGETABLE OILS ON THE SURVIVAL RATE OF X-IRRADIATED MICE. Kurt Flemming and Christa Flemming (Heiligenberg-Instituts, Ger. and Universität, Freiburg i. B.). Strahlentherapie, 125: 273-80(Oct. 1964). (In German)

Intraperitoneal injection of 1 ml of olive oil showed a prophylactic and therapeutic effect against irradiation with sublethal x ray doses in male and female mice. The same prophylactic effect was obtained when the injection was done 1 or 24 hours prior to irradiation. The effect of olive oil was determined after using 0.25 to 2.0 ml. Preceding intraperitoneal injection of olive oil did not influence the toxic effect of intraperitoneally injected cyclohexanonperoxide. Peanut oil, flax oil, sunflower oil, and paraffin also showed a prophylactic and therapeutic effect, cotton seed oil was ineffective. The mechanism of the substances investigated could not be explained. A specific as well as a nonspecific effect are discussed. (auth)

209 EFFECTS OF ANABOLIC HORMONE ON THE COURSE OF RADIATION INJURY IN THE WHITE MOUSE. Kurt Loewit (Universität, Innsbruck). Strahlentherapie, 125: 281-98(Oct. 1964). (In German)

The effects of pre-treatment of male white mice with anabolic hormones against total-body irradiation was investigated. The following anabolic effects were observed: increase in survival rate after 30 days; increase in reticulocyte count 16 days after irradiation; decrease of leucopenia 5 days after irradiation; slight inhibition of weight loss and increase in total vitality; and signs of an accelerated bone marrow regeneration, as well as a protection of the testicular tissue. (auth)

210 A NEW RADIOSENSITIZING COMPOUND AND ITS MECHANISM OF ACTION. Adolf Wacker (Universität, Frankfurt am Main). Strahlentherapie, Sonderbaende, 49: 126-9(1962). (In German)

The radiosensitizing effect of 5-bromouracil were studied and compared with the effects of thymine. Effects on DNA formation and on cells were determined. (M.C.G.)

211 EFFECTS OF DIFFERENT RADIOPROTECTIVE MATERIALS ON THE RADIOSENSITIVITY OF EHRLICH CARCINOMA IN VITRO AND IN VIVO. Ruprecht Koch and Dieter Klemm (Universität, Freiburg i. B.). Strahlentherapie, Sonderbaende, 49: 138-41(1962). (In German)

Cysteamine, nicotinic acid amide, thiourea, and d-penicillamine were studied to determine their effects on the radiosensitivity of Ehrlich carcinoma. Results are presented in graphs. Cysteamine and nicotinic acid amide showed clear protective effects. Thiourea and penicillamine increased the radiosensitivity of the cells. (M.C.G.)

212 EFFECTS OF PROPHYLACTIC MATERIALS ON RADIOINDUCED INHIBITION OF IRON INCORPORATION IN ERYTHROCYTES. Hans A. Kuenkel and Hans-Joerg Mauss (Universität, Hamburg). Strahlentherapie, Sonderbaende, 49: 234-7(1962). (In German)

The effects cysteine, AET, or serotonin on radioinduced reduction of iron incorporation in erythrocytes after whole-body irradiation of rats with x radiation doses between 600 and 800 R were studied. Results are presented in graphs. Protective effects of the substances were apparent in the first 24 hr. (M.C.G.)

213 ON RADIATION INJURIES AND BONE MARROW TRANSPLANTATION. A. Szirmai. Z. Ges. Inn. Med. Ihre Grenzgebiete, 18: 37-40(Jan. 1, 1963). (In German)

In animals, intravenous transplantation of bone marrow cells is the most effective treatment for exposure to supralethal dosages of radiation. There are no immunological problems when autologous and isologous transfusions are performed. These accelerate the regeneration of the bone marrow, hinder leukopenia, and reduce fatalities. Sometimes a secondary syndrome appears in animals that receive autologous transfusions. This consists of clinical symptoms such as anorexia, diarrhea, weight loss, tendency toward infections, and dermatoses. Along with anemia and lymphocytopenia, there are histological changes, such as lymphatic aplasia, resulting from reticuloendothelial and plasmocytic hyperplasia, and fibrosis. In humans, transplantation of homologous bone marrow into patients who have been treated previously with adrenocortical hormones or sublethal whole-body radiation is not effective. In order to obtain a sufficient volume of cells to transplant, punctures are made at several points in the donor's sternum, the pelvic ridge, or the spina iliaca posterior and anterior. Excess fat is removed by pipetting or centrifugation. The reticular cells should be grouped in clusters of no more than 3 or 5 cells before injection as a suspension. Sometimes small amounts can be introduced into the marrow spaces of the os ilium and the sternum. If intraperitoneal injection is used, more cells are required than with intravenous injection. Intracardial, intrathoracic, or intralineal injection has been used, but not subcutaneous or intramuscular injections. The time of injection varies somewhat. In mice, marrow cell injection can be delayed several days after irradiation without effect on survival, but in man injection is required very soon after irradiation. The fate of the injected cells can be followed by the ^{51}Cr labeled erythrocyte survival test. In patients exposed to from 650 to 1000 rem who received bone marrow, myelopoietic activity was resumed in ~ one month, and no secondary syndrome appeared. Transplantation of cells for idiopathic aplastic anemia has been unsuccessful. Several cases of successful transplantation have been reported where the recipient's marrow had become aplastic after treatment with cytostatic drugs. Results are generally unfavorable when marrow cells are transplanted for leukemia or other tumor conditions. (BBB)

Radiation Hazards and Protection

Refer also to abstracts 251 and 699.

214 (HW-81746(p.3.77-80)) EVALUATION OF FIELD GAMMA-RAY SPECTROMETRIC MEASUREMENTS. R. W. Perkins and H. G. Rieck, Jr. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

The feasibility and value of the direct gamma-spectrometric analysis of the Columbia River and of the atmosphere were investigated. These measurements showed that several radionuclides can be measured directly in the river and in the atmosphere by use of portable gamma ray spectrometric equipment. (auth)

215 (HW-81746(p.3.81)) PRELIMINARY MEASUREMENTS OF THE ADSORPTION OF REACTOR EFFLUENT WATER RADIONUCLIDES BY COLUMBIA RIVER WATER PARTICLES. L. L. Humphreys and R. W. Perkins (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Overall rates of absorption of reactor effluent water radioisotopes (^{56}Mn, ^{24}Na, ^{239}Np, ^{51}Cr, ^{64}Cu, ^{46}Sc, ^{65}Zn, and ^{140}La) by Columbia River water particles were measured. In the first minute of contact, absorption ranged from 0.2 to 14%. This was 25 to 40% of that occurring in 1500 min. (M.C.G.)

216 (JPRS-26500) METABOLISM DURING RADIATION INJURIES. N. F. Lipkan. Translated from p.45-136;

165 of "Elementy Radiatsionnoy Biologii i Biokhimii," Chast' II, Kiev, 1963. 79p. (TT-64-41758). $3.00(OTS).

The severity of radiation injuries can be influenced by the nutritional state at the time of irradiation and during the recovery period. Results are summarized from a number of studies on the effects of radiation on metabolic processes in animals. Topics discussed include radiochemical processes in tissues; radiation effects on the metabolism of nucleic acids, carbohydrates, fats, minerals, and water; radiation effects on oxidation-reduction process; radioinduced changes in the biological activity of enzymes, hormones, and vitamins; and the effects of radiation injuries on metabolism in individual systems, organs, and tissues. It is concluded that a diet rich in proteins, vitamins, and certain green vegetables can play a role in normalizing metabolic disturbances induced by radiation. (C.H.)

217 (JPRS-26542(p.1-5)) RADIOPROTECTIVE PROPERTIES OF ADRENOCORTICOTROPHIC HORMONE (ACTH). L. V. Orlova, S. P. Klimova, and V. M. Rodionov. Translated from Med. Radiol., 9: No. 6, 19-21(June 1964).

Preparations of ACTH without prolonged action did not afford protection to rats when given daily for six days prior to irradiation. Absence of protection of ACTH preparations without prolonged action was not connected with a seasonal change of sensitivity in animals. Preparations of ACTH with prolonged action increased the survival of rats when administered for six days prior to irradiation. (auth)

218 (JPRS-26542(p.6-10)) USE OF LAGOCHYLUS IN ACUTE RADIATION SICKNESS INDUCED BY Po^{210}. S. M. Mikhaylovich. Translated from Med. Radiol., 9: No. 6, 43-5(June 1964).

Subcutaneous injection of ^{210}Po at the rate of 0.1, 0.05, and 0.06 millicurie/kilogram causes acute radiation sickness and a hemorrhagic syndrome to develop in mice, rats, and dogs. In acute poisoning by polonium of mice, rats, and dogs the use of lagochylus had a positive effect in altering the permeability and fragility of skin capillaries. Injection of poisoned animals with lagochylus with a unithiol base significantly modified the course of the lesion, decreased the degree of hemorrhagic phenomena, and prevented their development. Preparations of lagochylus in treating acute radiation sickness induced by polonium should be used in combination with unithiol. (auth)

219 (JPRS-26725(p.18-24)) CLINICO-HEMATOLOGICAL, BIOCHEMICAL, AND MORPHOLOGICAL CHANGES IN THE RESTORATIVE PERIOD DURING THE THERAPY OF RADIATION SICKNESS. E. (Ye.) A. Abaturova, N. K. Sviridov, G. N. Elpat'evskaya (Yelpat'yevskaya), and E. (Ye.) A. Zuykova. Translated from Byul. Eksperim. Biol. i Med., 57: No. 8, 34-8(1964).

Dogs with radiation sickness were treated with batyl alcohol and leucogen in tablets and after 7 days were given kafiride. The dogs also received Biomycin during the first 10 days and Levomycetin during the second 10 days after irradiation. Batyl alcohol was administered for one month and leucogen and kafiride for 2 to 2.5 mo. If the hematological indicators had not recovered by the 3rd or 4th month, batyl alcohol and kafiride were given for 2 to 4 weeks. Two of the 14 dogs given this medical treatment died. The other dogs had only mild symptoms of radiation sickness. Twelve of the 15 control dogs died during the first 3 weeks after irradiation and the others had severe symptoms of radiation sickness. Hematological, biochemical, and morphological changes observed during the treatment period are described. It was concluded that the therapeutic action of the drugs was due to their influence on the animal as a whole and not on individual processes disrupted by the effects of irradiation. (C.H.)

220 (JPRS-26725(p.25-30)) PROPHYLACTIC ACTION OF AEROIONIZATION IN ACUTE RADIATION SICKNESS. L. V. Serova and M. I. Fedotova. Translated from Byul. Eksperim. Biol. i Med., 57: No. 8, 60-3(1964).

Results are summarized from a series of 10 experiments on the effects of positive and negative ionization of environmental air on the course of radiation sickness in rats exposed to lethal doses of γ radiation. The animals were exposed to the ionized air for 15 or 30 min a day for 14 to 28 days. Seasonal differences in response were found, with best results obtained after a course of 28 treatments using negative ions given in April and May. Studies were made on the peripheral blood during all treatments. (C.H.)

221 (JPRS-26757(p.11-14)) EFFECT OF FREE-RADICAL PROCESS INHIBITORS ON IRRADIATED YEAST CELLS. Yu. P. Kozlov and A. I. Gorin. Translated from Nauchn. Dokl. Vysshei Shkoly, Biol. Nauki, No. 2, 91-3 (1964).

Propyl gallate, an inhibitor of chain oxidative processes, and vinyl pyrrolidine, which has a protective action in irradiated plants, had a protective effect on yeast cells exposed to γ radiation when the compounds were used individually or jointly. The survival rate of the yeast cells was determined by the number of normal colonies 24 hr after culturing on a nutritive medium. The data are compared with results obtained when the electron paramagnetic resonance (EPR) method was used to study radiation effects in yeast. This method showed that free radicals were present in living yeast cells and that their concentration increased with radiation exposure. Treatment of the yeast cell suspensions with either propyl gallate or vinyl pyrrolidine considerably attenuated the EPR signal, but did not alter the character of the spectra. It was concluded that natural substances that are eliminated by administration of propyl gallate and vinyl pyrrolidine play an active role in the free radical states that develop in irradiated yeast cells. (C.H.)

222 (JPRS-26757(p.7-10)) MECHANISM OF THE RADIOMIMETIC ACTION OF OXIDIZED OLEIC ACID ON THE ANIMAL ORGANISM. E. (Ye.) N. Goncharenko and Yu. B. Kudryashov. Translated from Nauchn. Dokl. Vysshei Shkoly, Biol. Nauki, No. 2, 88-90(1964).

Aminoethylisothiuronium (AET) protected rats from the effects of whole-body exposure to 200 R γ radiation and had some protective effect against doses of 500 R radiation. A protective effect was also provided by AET against injections of oxidized oleic acid (00A), previously found to have a radiomimetic effect in rats. Exposure of protected rats to both 00A and 200 R γ radiation resulted in the death of 50% of the animals by the 50th-day. Data are included from studies on various combinations of the two agents. The synergistic effects of 00A and γ radiation are discussed. It was concluded that the protective effect exerted by AET against both compounds is proof of the hypothesis that the oxidation products of unsaturated fatty acids participate in the primary reactions of radiation injuries in animals. (C.H.)

223 (JPRS-27006) COMBATTING RADIATION SICKNESS. A. Lebedinskii (Lebedinskiy). Translated from p.3 of "Izvestiya," Aug. 18, 1964. 5p. (TT-64-51262). $1.00 (OTS).

The etiology of radiation sickness is reviewed, and various methods of prevention and treatment are considered. Emphasis is placed on the effects of blood transfusions and bone marrow transfusions on the restoration of hematopoietic function in irradiated animals. (C.H.)

224 OCCUPATIONAL RADIATION INJURIES OF THE SKIN OF THE HANDS. Jaromir Kolar, Z. Kral, H. Peskova, V. Svab, and R. Vrabec (Charles Univ., Prague). Radiobiol. Radiotherap., 3: 377-81(1962). (In German)

Fifty-one persons with occupational radiation damage of the skin were surveyed and all had symptoms of ulceration or cancer development. Most of them were physicians or technical personnel who were not radiologically trained. Among them were 24 surgeons, 10 phthisiologists, 7 internists, and 4 radiologists. The youngest patient was a 33-yr-old surgeon. The average age was 53. The average interval for appearance of injury was 23 yr, but for surgeons it was only 16 yr. Five have died. In 76.5% a malignant tumor appeared, and in the others skin changes were nonmalignant. The skin injuries were characterized by atrophy, rhagades, pigmentation changes, telangiectases, hyperkeratosis, dryness, fissures, and recurrent infections.

Typical changes were observed in the fingernails. Most changes were squamous cell cancers with or without cornification. There was one basilioma. One occupational radiosarcoma that was a fibrosarcoma was observed. This is only the third one reported in the literature. Perhaps the reason that the skin changes appeared in the surgeons so early was that the skin resistance was lowered by the constant mechanical and chemical irritation to which they were subjected. The incidence of malignant tumors was high for the surgeons, and amounted to 21 out of 24 tumors observed. All of the patients were surgically treated, and the defects repaired by skin grafts. (TCO)

225 HAZARDS IN UROLOGICAL X RAY DIAGNOSIS. F. H. Redlich and W. Krebs (Staedtische Hufeland-Krankenhaus, Berlin). Z. Aerztl. Fortbild., 57: 142-51(Feb. 1, 1963). (In German)

Somatic and genetic injuries resulting from urological radiodiagnosis with x radiation are discussed. Protective measures considered include methods for controlling exposure and judicious choice of contrast media. (TCO)

226 RADIATION GENETICS. William B. Looney and M. L. Pardue. p.311-39 of "Atomic Medicine. Fourth Edition." Baltimore, The Williams and Wilkins Co., 1964.

Genetic effects of radiation are reviewed at two levels: molecular and morphological. Gene mutagenesis and doses required for doubling chromosomal aberrations are identified as methods of detecting medically induced radiation damage in man. Genetically significant radiation doses and ways of reducing gonadal doses are considered for: radiodiagnosis, radiotherapy, clinical radioisotope procedures, and dental radiography. (H.M.G.)

227 CORRELATIONS BETWEEN PROTECTION AGAINST RADIATION AND INDUSTRIAL MEDICINE. J. Rodier and E. Mazaury. 13p. (CONF-705-1)

From 14th International Congress of Occupational Health, Madrid, Sept. 1963.

In the area of radioactive safety in a nuclear center, the Service for Protection against Radiation and the Medical Service have complementary tasks. The first was essentially a preventative role, attempting to avoid all abnormal exposure of personnel. The second controls the health state of the individuals working in the controlled zone. It must verify the efficiency of the precautions taken. Each must know the results obtained by the other. Only their joint defects can guarantee a maximum of safety to the personnel. (tr-auth)

Radiotherapy and Radiodiagnosis

Refer also to abstract 1109.

228 (ANL-6910) RECENT DEVELOPMENTS IN THE THEORY OF NEUTRON CAPTURE THERAPY (JANUARY 1958) AND SYSTEMS FOR NEUTRON CAPTURE THERAPY: GENERAL CONSIDERATIONS (1959). Norman A. Frigerio (Argonne National Lab., Ill.). June 1964. Contract W-31-109-eng-38. 40p. Dep.; $2.00(cy), 1(mn) OTS.

Part I: Interest in neutron capture therapy has centered, to date, on the use of the ^{6}Li and $^{10}B(n,\alpha)$ reactions. This has been due primarily to two facts: they possess high thermal cross sections, and the reaction products have very short ranges and high ionization densities. Results have been encouraging, but difficulties of a chemical and physiological nature remain unsolved for these two nuclides. Ionic lithium and boron localize poorly in tumors, and lithium compounds which do not release ionized lithium under physiological conditions have not yet been synthesized. Boronic acid derivatives of the acid azo dyes such as Evans blue and trypan blue have given promising results. However, recent experience with these two compounds has been that concentration of the dye in vivo is not accompanied by concentration of the boron, which appears to be hydrolyzed to free boric acid by enzymes in the organism before a high differential concentration can be achieved in the neoplasm. Possible activatable nuclides for use in neutron capture therapy and the dose delivered to both normal and neoplastic tissues by neutron activation processes are discussed. (60 references.) Part II. A broad survey was made of processes and materials having potential usefulness for neutron capture therapy. Consideration was given to the physical and chemical parameters of the processes involved in relation to the requirements imposed by the biological characteristics of lesions and of the organism as a whole. A number of promising systems are proposed; those which have been tested in the laboratory have given results in good agreement with theoretical expectations. It is concluded that optimum therapeutic results will be from the use of monoenergetic epithermal neutrons together with resonance capture and fissionable nuclides. The synthesis of resonance-stabilized compounds of activatable nuclides, in which the biochemical behavior is essentially independent of the key nuclide, is described, and such compounds promise to provide a number of useful therapeutic, diagnostic, and research tools. (64 references.) (auth)

229 (JPRS-26960(p.1-4)) CHANGES IN I^{131} CONTENT IN THE THYROID GLAND OF THYROTOXICOSIS PATIENTS DURING ITS ADMINISTRATION IN DIAGNOSIS AND THERAPY. Yu. E. Livergant and E. D. Chebotareva. Translated from Med. Radiol., 9: No. 8, 16-18(Aug. 1964).

The percentage of accumulation of ^{131}I by the thyroid gland in 95 thyrotoxicosis patients 24 hr after the administration of various tracer and therapeutic doses was determined in relation to the degree of ^{131}I increase in the gland. The data indicate that the accumulation of ^{131}I in the thyroid gland in thyrotoxicosis is practically the same when large or small quantities of the isotope are administered. (C.H.)

230 (JPRS-26960(p.10-13)) EXPERIMENTAL INVESTIGATION OF THE THYROID FUNCTION WITH THE AIR OF I^{132}. N. D. Koval'chuk, V. V. Sedov, and V. A. Sokolov. Translated from Med. Radiol., 9: No. 8, 31-3 (Aug. 1964).

Iodine-132, obtained in the laboratory from ^{132}Te generators, was used in tissue distribution studies in rats and dogs. Results indicated that the ratio of ^{312}I obtained for counting rates of the neck and the thigh from 1 to 5 hr after adminstration of the isotope were adequate for studies of the functional state of the thyroid. It was concluded that ^{132}I can be used for diagnostic tests of thyroid diseases by scanning from 3 to 5 hr after the oral administration of a 2 μc/kg dose. (C.H.)

231 (JPRS-26960(p.29-32)) SPECIALIZATION IN PROTECTIVE RADIOLOGICAL TECHNIQUE. A. Ya. Berlovskii. Translated from Med. Radiol., 9: No. 8, 78-80 (Aug. 1964).

A semiautomated production line for working with closed radioactive sources in the treatment of gynecological conditions is described. The advantages and disadvantages of semiautomatic production line techniques in radiotherapy are discussed. (C.H.)

232 CASE OF RADIATION NEPHROPATHY WITH PARTICULAR REFERENCE TO THE HISTOLOGIC PICTURE. Mario Fernando Rosi and Paolo Pagnini (Università, Florence). Arch. "De Vecchi" Anat. Patol. Med. Clin., 36: 1247-68(Dec. 1961). (In Italian)

A 50-yr-old man with a retroperitoneal tumor that compressed the biliary tract was subjected to cholecystogastrectomy. A biopsy of the tumor mass showed the tumor to be a leiomyosarcoma. The symptoms of biliary obstruction disappeared but it was decided to use telecobalt therapy in the upper quadrants of the abdomen. The total dose administrated was 4000 Rad, distributed over 10 sessions per field of 18 × 16 cm. The volume of the tumor was notably reduced and for six months the patient was free of symptoms, after which time he began to show anorexia, asthenia, and intense headaches. A renal biopsy taken 8 months after telecobalt therapy revealed nephrosclerosis. The sudden appearance of the symptoms of renal damage

in a patient with normal renal function following the use of telecobalt therapy suggested an etiologic relation between the nephropathy and radiation. The removal of the radiation-damaged kidney relieved the patient of all symptoms. It is pointed out that the greatest damage is produced by radiation in the renal vessels and not in the tubular epithelium, because the changes observed in the latter are reversible. It is noted that the use of the term nephritis as a result of radiation is improper since the histologic picture shows nothing that suggests inflammation. (TCO)

233 LOW DOSAGE ROENTGEN THERAPY OF VERRUCAE PLANTARIS: TECHNIQUE AND RESULTS IN 1,250 PATIENTS. H. E. Duggan (Univ. of Alberta, Edmonton, Can.). Arch. Dermatol., 90: 202-4(Aug. 1964).

In view of increasing concern over the use of ionizing radiations in the treatment of benign conditions, an improved technique was sought whereby radiation injuries resulting from radiotherapy of warts could be avoided. Previous studies which reported injurious effects of radiation in such treatment are reviewed. The present study involves a group of 1250 patients with verrucae plantaris treated with low exposures of external x radiation. Of 1065 patients who were followed, the lesion was cured in 1022 or 96%, and no instance of radiation damage was observed. This series indicates that a very high percentage of cures in plantar warts can be obtained by using low dosage x radiation fractionated over two to four weeks. The skin surrounding the wart was shielded with lead so as to leave a rim of 0.5 to 1 mm around the wart. The x-ray factors were: 75 kv peak, 5 ma, no filter, 17 cm target skin distance, half-value layer 0.8 mm Al. The usual dose was 345 to 360 r with backscatter. The patient was seen again in two weeks, at which time, the wart, if still active, was pared and the x-ray treatment repeated. Only in very rare instances were more than three treatments given. For warts on the toes and all warts in children (under age 12 yr) the exposure was usually reduced to 230 to 250 R per treatment. For seven years prior to the use of this technique, a higher radiation dose was used in another group of patients, but no ill effects have been observed. (BBB)

234 DIFFERENTIATION OF BENIGN AND MALIGNANT THYROID NODULES BY SCINTISCAN. Katsutaro Shimaoka and Joseph E. Sokal (Roswell Park Memorial Inst., Buffalo). Arch. Internal Med., 114: 36-9(July 1964).

The study explored the possibility of using scintiscanning to distinguish between benign and malignant thyroid nodules to help decide whether a nontoxic nodular goiter requires surgical treatment. The potential contribution of this technique in the treatment of such goiters was assessed in 180 patients. Most patients received a 5-μC tracer dose of carrier-free ^{131}I by mouth, as NaI. In a few instances larger doses were used; the largest was 50 μC. Thyroidal accumulation of ^{131}I was determined 48 hr after administration of the tracer dose, and a scintiscan of the thyroid was obtained by a photoscanner which was capable of sufficient resolution to identify areas of significantly decreased or increased ^{131}I uptake about 1 cm in diam. Thyroid nodules were classified as cold if clearly decreased ^{131}I uptake could be identified in areas of the scintiscans corresponding to their location, and as hot if the scintiscans showed appropriate areas of increased ^{131}I uptake. The remaining nodules were classified as warm. The results showed that there was no significant difference in the thyroidal ^{131}I accumulation at 48 hr between the 49 patients with normal thyroids and those with nontoxic nodular goiter. No cancers were found among the 12 patients with hot nodules. The incidence of carcinoma was higher among the cold nodules than the warm ones; however, this difference was not significant. There was no difference in the frequency of carcinoma among uninodular and multinodular goiters. Most of the larger malignant nodules could be identified as hypofunctioning areas on the scintiscans; however, two of the three smaller lesions could not be differentiated from normally functioning thyroid tissue. It is concluded that although the scintiscan is a useful aid in the study of patients with thyroid disease, and may occasionally be helpful in excluding thyroid cancer, it cannot be expected to solve the problem of differentiating between benign and malignant goiters. (BBB)

235 PREOPERATIVE USE OF A SINGLE DOSE OF X RAYS: LOCAL CANCER RECURRENCE. W. Rodger Inch and John A McCredie (Victoria Hospital, London, Ont.). Arch. Surg., 89: 398-406(Aug. 1964).

Experimental studies were conducted in mice to determine the optimal time for surgical removal of a previously irradiated tumor. Earlier it was found that a single dose of x rays (2000 rad) given to isologous implants of the spontaneous mammary carcinoma in C3H/HeJ mice 24 hr before operation decreased local cancer recurrence but was less effective when given to the operative site 24 hr after removal of the tumor. In the present experiments, isoimplants (0.40 ± 0.15 cm^2) of the same carcinoma in C3H/HeJ mice were given a single dose of x rays (2000 rad) at one, six, or 12 days before excision of the tumor. Controls were given the same dose to normal tissues one day before operation, and the animals were observed for local recurrence during 100 days. This dose killed many of the cancer cells and temporarily decreased the size of the tumor. Recurrence was least when excision was performed six days after irradiation; it was less effective when the tumor was excised on the 1st or 12th day. Damage to the cancer cells was therefore still increasing one day after the radiation, while at 12 days nutrition had improved, recovery had taken place among the cells that had maintained their reproductive integrity, and they were dividing again. One day after irradiation of tumor cells their nuclei were larger, vacuolated, and none showed normal mitosis. At six days the nuclei were still large, many were pyknotic and fragmented, and many monocytes and white cells were present. At 12 days areas of necrosis associated with inflammatory cell and fibroblast infiltration and normal mitoses were seen. Local recurrences occurred mainly within 50 days of excision of the tumors, with 10% or less developing during the next 50 days. The single dose of 2000 rad used in this study induced a moist reaction in the skin and loss of hair and was probably the largest that could safely be used. In patients the dose of radiation tolerated by the normal tissues varies at different sites and depends mainly on the bood supply to the region and presence of sensitive organs, but it has been possible to give preoperatively about the same dose (2000 R) in one treatment to patients with carcinoma of the breast and rectum without producing excessive reaction in the normal tissues or impairing wound healing. (BBB)

236 NUCLEAR MEDICINE AT THE INSTITUTE FOR MEDICINE. H. W. Knipping and R. W. Felten (Kernforschungsanlage, Julich, Ger.). Atompraxis, 10: 432-4 (Sept.-Oct. 1964). (In German)

Some of the principal parts of the program to be undertaken at the almost completed Institute for Medicine are reviewed. These include studies on diagnostic applications of short-lived isotopes, refinement of diagnostic methods for carcinomas, labeling studies on cancer cells, radiograms of organs such as gamma retina, diagnosis of circulatory illnesses, and radiation burden. (J.S.R.)

237 TRANSIENT RADIATION MYELOPATHY (WITH REFERENCE TO LHERMITTE'S SIGN OF ELECTRICAL PARAESTHESIA). Arthur Jones (St. Bartholomew's Hospital, London). Brit. J. Radiol., 37: 727-44 (Oct. 1964).

Seven cases of patients receiving external irradiation for neoplasms of the upper respiratory tract are reported. The tumors treated had the common feature of actual or potential lymph node metastasis that required irradiation of the lymphatic field wide of the primary tumor. Consequently, the cervical spinal cord was exposed to irradiation of varying extent and dosage. Electric paraesthesia, induced by neck flexion, was experienced by all seven patients. Pathological study of the radiation myelopathy led to the conclusion that the effect was an interference with tumors and synthesis of new myelin. It is postulated that the irradiation inhibits the activity of a proportion of the oligodendroglia along the axons of sensory neurones in the irradiated zone. (H.M.G.)

238 DECREMENT LINES: A NEW PRESENTATION OF DATA IN COBALT 60 BEAM DOSIMETRY. P. G. Orchard (Royal Hants Hospital, Southampton, Eng. and Royal Victoria Hospital, Bournemouth, Eng.). Brit. J. Radiol., 37: 756-63(Oct. 1964).

A method of describing the dose distribution within a beam is outlined in which the dose distribution in a ^{60}Co beam is related to the central axis depth dose by use of decrement lines, which are defined and shown to be families of straight lines for the Hunslet apparatus and possibly for the Orbitron. As compared with the usual method of preparing isodose charts, the decrement system is shown to reduce the necessary experimental work to very small amounts without loss of accuracy, and to have advantages in overall accuracy as a method of presentation of beam data. The practical use of the system in the correction for surface obliquity and in the calculation of moving-field distributions is discussed. (auth)

239 INSTRUMENTAL AND TECHNICAL NOTES. A "WEDGED COUNTER" FOR THYROID MEASUREMENTS. F. M. Hall and D. R. White (Kent and Canterbury Hospital, Canterbury, Kent, Eng.). Brit. J. Radiol., 37: 794-5(Oct. 1964).

A method for measuring thyroid radioactivity is described that is ideally suited to the patient confined to bed and that allows accurate results to be obtained without the need for any correction for thyroid-counter distances. Features of design include two Pb geiger tubes mounted with their axes at a 90° angle, a uniform longitudinal response of the tubes, and lead wedges. The apparatus is compact, portable, and usually used with 20 μc doses of ^{131}I and a Panax ratemeter. (H.M.G.)

240 COMPENSATION FOR TISSUE INHOMOGENEITY IN COBALT 60 THERAPY. F. Ellis, A. Feldman, and R. Oliver (Churchill Hospital, Oxford). Brit. J. Radiol., 37: 795-8(Oct. 1964).

Clinical application of a compensator technique of correcting for tissue inhomogeneity in the ^{60}Co beam path is discussed. Use of the method in making esophageal dose measurements is described. Measurements in phantoms and in vivo confirmed reduction in dose estimation errors applying when the effects of lung and bone were neglected. (H.M.G.)

241 THE GRENZ-RAY OUTPUT CHARACTERISTICS OF A SUPERFICIAL THERAPY MACHINE. F. S. Stewart and D. E. A. Jones (Mount Vernon Hospital, Northwood, Middx, Eng.). Brit. J. Radiol., 37: 798-801(Oct. 1964).

Observation of an unexpected relationship between x-ray output and tube current when the latter varied from the specified value at the 10 kv setting on a superficial therapy unit, the Dermopan, is reported. It is shown that by means of a simple adjustment of the control circuit of the machine, the characteristic can be turned to good account by providing improved dose control. (H.M.G.)

242 ASSESSMENT OF RESPONSE OF CERVICAL CANCERS TO IRRADIATION BY ROUTINE HISTOLOGICAL METHODS. L. Walter (Hammersmith Hospital, London), C. V. Harrison, A. Glucksmann, and C. P. Cherry. Brit. Med. J., 1: 1673-5(June 27, 1364).

Valuable prognostic information can be obtained from ordinary routine examination of serial biopsies taken from patients undergoing radiotherapy for cancer of the uterine cervix. The original method of examining serial biopsies from tumors before and during radiotherapy was devised (in 1941) to determine whether the early histologic changes induced by irradiation could serve as a means of assessing the radiocurability of the individual tumor. Since this research project was started it has been shown that such a histologic method gives a reliable indication of the local response to radiotherapy of the tumor in individual patients. In the early descriptions of the method cell counts in selected comparable areas of serial biopsies were advocated, but it has since been proved that cell counts are unnecessary and that a modified and simplified form of the original technique gives as reliable an assessment of the local radiation response. The techniques necessary are described and a comparison is made of the findings on the same group of 210 patients by research workers and by a department carrying out routine reporting. An unfavorable response to treatment is indicated if the first post-irradiation biopsy contains many viable tumor cells, and especially if there are normal-looking mitoses. The occurrence of only a minor increase in differentiation is also evidence of a poor response but is of less importance. The presence of large or bizarre cells is of no prognostic value. A favorable response to treatment is indicated when, in the first postirradiation biopsy, normal-looking mitoses in tumor cells cannot be found and when viable tumor cells are scanty. An increase in the degree and extent of keratinization between the first and second post-irradiation biopsies is also a good sign. In a minority of cases the radiation responses must be recorded as doubtful. The high degree of agreement which was obtained between prognoses based on a quantitative analysis and those based on pathologic reports of radiation changes seen in serial biopsies shows that the histologic assessment need not be a laborious procedure and is well within the scope of a routine pathology department. The striking differences in the clinical result for cases with an unfavorable and a favorable prognosis indicate that the assessment of radiation changes in serial biopsies can be of use to the therapist in deciding on additional treatment in individual patients. (BBB)

243 EXPERIMENTAL BASIS FOR THE USE OF PRE-OPERATIVE IRRADIATION TO PREVENT GROWTH OF TUMOR CELLS DISSEMINATED AT SURGERY. Robert R. Smith (Emory Univ., Atlanta). Bull. Schweiz. Akad. Med. Wiss., 20: 179-89(1964).

An attempt was made to alter intact tumor cells prior to surgical removal so that any cells disseminated in wounds, or at distant sites, would be unable to implant and grow. Five different transplantable tumor and strain specific mice were used. The tumor cell suspension used for transplant was prepared by passing fresh tumor through a cytosieve. Injections were given through a 27-gauge needle into the tail vein for intravenous studies and into thigh muscles for intramuscular growth. The axillary wounds were made to simulate a radical mastectomy wound and the tumor suspension was deposited into the open wound. The donor tumor was prepared by an intrathigh injection of tumor inoculum. When the tumor in the thigh reached the size of 10 to 12 mm, radiation was given to the tumor with 200-kv x rays at 341 R/min. The animal was protected in a lead box with only the tumor-bearing thigh exposed. The x-ray dose used varied from 170 to 2500 R. The time interval between in vivo radiation of the donor tumor and transplantation was 24 hr. Growth of tumor at various sites was measured and found to be decreased by more than 90% over control animals. The x-ray doses used were not large enough to stop growth of a primary tumor or cause regression of a growing implant. Considerable reduction in the number of disseminated implants was observed when only 715 R was used; however, to approach the 98–100% level of effectiveness, 2000 R was usually necessary. The amount of radiation necessary to produce the desired reduction in growth of implants varied with each tumor system used. It is hypothesized that these cells were damaged by irradiation in vivo, and that after dissemination from the parent tumor they were unable to implant or grow. (TCO)

244 EUSTACHIAN TUBE OBSTRUCTION AND RADIATION THERAPY. John S. MacKay. Can. Med. Assoc. J., 91: 449(Aug. 29, 1964).

The treatment of hypertrophied pharyngeal lymphoid tissue by radiotherapy in a series of 194 patients, two-thirds of whom were under 15 yr of age, is discussed. It is suggested that in view of its carcinogenic properties, the use of radiation therapy for any benign condition is highly questionable, and absolutely contraindicated in such cases as those described, because of the association of this form of treatment with carcinoma of the thyroid. The risk may be small and the benefits great, but it is suggested that even if all of these 194 patients were completely relieved of deafness and earache, and only one developed carcinoma of the thyroid, the price has been too high. At the very

least, each patient should have the opportunity to make his own decision after being presented the relevant data. The report refers to long-term follow-up of an average of 4.3 years. However, with treatment of this type, especially when many of the patients are so young, 40 years, rather than four, must pass before it is possible to begin to assess the final result. (BBB)

245 OBSERVATION ON THE RADIATION SENSITIVITY OF A CHONDROOSTEOID SARCOMA. H.-J. Maurer (Universität, Bonn). Chirurg, 33: 561-3(Dec. 1962). (In German)

A chondroplastic sarcoma of the femur with partial transition to osteoid sarcoma was treated with 8000 R of x ray over a period of 14 days. Because of the histological structure of the tumor the femur was amputated at 4 weeks postradiation. Comparison of the histological findings before and after radiation showed that the tumor tissues had been destroyed by the radiation, and that normal tissue was reappearing. Since the interval between irradiation and amputation was only 4 weeks, scar formation was incomplete, but there was no question that the tumor responded to the radiation treatment. Pathological-anatomical study of sections showed that a greyish white soft tissue at and below the epiphyseal line of the tibia was interspersed with empty spaces, and there were some small hemorrhages. The grey tissue contained islets of cartilaginous growth surrounded by chondroid tissue consisting of polymorphic cells, partially necrotic, but with some evidence of chondroid reticular bone. Most of the cells were anuclear. The borders of the tissue were edematous. Many hyaline cartilage islets were nonnucleated, and stained poorly. Others contained small retracted nuclei. The more mature chondroplastic components were intact, while the less mature chondroid and osteoid parts with a bony reticulum were extremely necrotic. The chondroid reticulum that contained bone salt appeared to be distorted in form. In contrast to previous reports for similar tumors, this sarcoma was sensitive to the radiation, with the mature portions exhibiting a lesser reaction than the more immature tissue. (BBB)

246 RETENTION OF RADIOIODINE BY SALIVARY GLANDS. M. Negri and E. E. Pochin (London Univ.). Clin. Sci., 21: 289-93(Dec. 1964).

Iodide is highly concentrated in human saliva relative to its concentration in plasma, and this concentration can be largely or completely inhibited by the administration of potassium perchlorate. It would be useful to inhibit the salivary concentration of radioiodine in this way during the examination of patients with thyroid carcinoma after treatment with radioiodine, since the presence of radioiodine in the salivary glands of such patients makes it difficult to detect or exclude the concentration of small amounts of radioiodine in remaining traces of functioning tumor tissue in the neck, particularly in submental lymphatic glands which are closely adjacent to salivary glands. Inhibition of salivary radioiodine concentration starts rapidly after the administration of $KClO_4$ and persists for several hours if appropriate doses are given; it was therefore anticipated that the salivary gland could be kept free of radioiodine for a period sufficient for the detection of any cervical sites of functioning tumor tissue in these patients. When this was attempted, however, it was found that, although the salivary concentration of radioiodine was rapidly reduced, as judged by measurements made on samples of saliva, the radioiodine content of the salivary glands, as indicated by profile counter measurements, was not discharged. Observations were therefore made on a group of patients who had had thyroid ablation and radioiodine treatment for thyroid carcinoma, and in whom little or no iodine-concentrating tumor tissue was detectable in the head or neck, so that the radioiodine content of the salivary glands could be followed readily by profile counting. In patients given $KClO_4$ one to four days after ^{131}I, a fall in salivary ^{131}I concentration was consistently observed, but the ^{131}I content of salivary glands was not significantly reduced, as judged by the profile counting measurements. If the ^{131}I measured was in fact within the salivary glands, it seems impossible to explain the observations on the basis of any time-lag between the formation and excretion of saliva, since radioiodine is known to appear in the saliva within a few minutes of an intravenous injection of the isotope, and since the salivary concentration remained low for some hours after the administration of perchlorate, while the gland content was unaffected. Two remaining possibilities are suggested: (1) perchlorate inhibits the discharge, but not the uptake, of iodide in high concentration by the salivary cells; or (2) part of the radioiodine entering salivary cells becomes temporarily fixed and accumulates within the cell in such a form that it is not dischargable by perchlorate; and that the activity measured in the gland is due mainly to such fixed radioiodine rather than to radioiodide passing through the gland into the saliva. In an attempt to distinguish between these possibilities, further observations were made on the amount of radioiodine present in the glands, and its variation with time after a radioiodine dose (but without administration of $KClO_4$). In 65 subjects under treatment for thyroid carcinoma, profile curves made one day after ^{131}I was given orally as iodide, a mean of 1.3% of the dose was found to be present over the salivary glands. Measurements made daily for a week showed the height of the salivary peak to decrease at about the same rate as the rate of urinary excretion decreased, both curves being at first ~ exponential with broadly similar half periods. The half period for urinary rates had a mean value of 0.50 days and that for salivary activity was 0.60 days. Neither hypothesis appeared to be excluded by this quantitative data. (BBB)

247 ACTIVATION OF TISSUE EQUIVALENT MATERIAL BY GAMMA RADIATION OF HIGH ENERGY. M. Ladu, M. Pelliccioni, and E. Rotondi (CNEN, Frascati, Italy). Energia Nucl. (Milan), 11: 570(Oct. 1964).

The dose absorbed (from the gamma beam of the Frascati Synchrotron) by tissue-equivalent plastic is found to depend on the residual activity produced in the plastic. This residual activity is attributed to radiation from the annihilation of positrons produced in the plastic by the following processes: $^{12}C(\gamma,n)^{11}C$, followed by positron decay $^{11}C \rightarrow {}^{11}B$. For a given exposure dose, the residual activity is found to be the same for gamma energies of 300 and 1000 Mev. The dose from this annihilation radiation must be added to the dose produced directly by the gamma beam. (T.F.H.)

248 RADIATION TREATMENT OF VULVAR CANCER. John-Erik Johnsson (Konung Gustav v Jubileumsklinik, Lund, Sweden). Geriatrics, 19: 447-52(June 1964).

Various methods which have been used for radiotherapy of vulvar cancer, and the results obtained with them, are reviewed, and an improved method is presented which provides a high cure rate. In the modified method, which was applied to 175 patients, two fields in each groin are irradiated with a 25-C teleradium apparatus. The distance between the centers of the fields is about 6 cm. The dose decreases rapidly with depth: about 3 cm under the skin the dose is only about half of the skin dose, which spares contiguous tissue. To insure a sufficiently large depth-dose, the apparatus is applied with moderate pressure against the skin over the area to be treated. Each field is given 2100 r in three days. In selected patients, 185-kv x rays may be used and delivered via a single field in each groin. The total dose delivered is the same as for telegamma radiation. If the inguinal lymph nodes have been excised and histologic examination shows signs of metastases, the area concerned is irradiated via a single field after the operation. The dose is varied according to the previous skin reaction. Surgical treatment consists of electrocoagulation of the entire vulva and, if spread of the inguinal lymph nodes is suspected, excision of the regional lymph nodes. Despite radiation treatment, follow-up study revealed metastases in the regional lymph nodes in 25% of those patients in whom no such spread had been suspected at the time of treatment. Treatment was therefore extended to include bilateral inguinal lymphadenectomy. Radiation is most often combined with surgery with extirpation of the vulva or excision of the regional lymph nodes, or both; the results achieved with radiation alone are much less favorable than those obtained with surgical

and combined treatment. It is concluded that radiation treatment of cancer of the vulva by conventional methods has proved much less satisfactory than was originally hoped. Radiation treatment, therefore, should be used mainly in combination with surgery. More recently, therapy with high-speed electrons has become available, and primary cures have been achieved in 100% of patients treated by this method alone. In addition, radionecrosis appears to be rare, but it is still too early to assess the late results. (BBB)

249 THE ROLE OF RADIOTHERAPY IN THE TREATMENT OF TUMORS IN CHILDREN. Dorothy Pearson (Christie Hospital and Holt Radium Inst., Manchester, Eng.). J. Clin. Pathol., 17: 423-6(July 1964).

An evaluation is made of the use of radiation to treat tumors in children, with emphasis on the increasing success of radiotherapy in this field and the possibility of avoiding injurious side-effects by proper choice of technique and dosage. Some unavoidable damage caused by irradiation of children is described. In treating malignant disease with radiation, the doses which have to be employed are bound to result in some damage to normal tissues with immediate and later sequelae. The immediate effects include skin reactions (usually today not severe), epilation when the scalp has to be treated, and reduction in the white cell count in the peripheral blood when large volumes are treated. These reactions, except in very small babies, are in no way greater than those experienced in adults. In recent years it has been realized that the kidney is relatively sensitive to x rays, and in retrospect it is obvious that in some of the earlier cases the kidney received a higher dose than it could tolerate and thereby suffered acute damage, with fatal consequences. This is now avoidable and care is taken to keep the dose to the kidney well below its tolerance. Due to the fact that the normal tissues in children are more actively growing than in adults, the later effects of radiation are more obvious. The two which are most apparent are the effect on bone growth, seen in the shortened trunk where radiation has been given to all or part of the spine, and the possible ovarian effects in girls who have had the lower abdomen treated. In five girls who had been irradiated in this region and reached the age at which the menarche is to be expected, two showed apparently normal development with menstruation, two developed normal secondary sex characteristics but have not menstruated, and one failed to develop completely. Many children treated for tumors of the central nervous system are left with residual defects, including blindness and mental retardation. It is possible that in some cases radiation may play a part in producing these, but it is often difficult to assess whether the tumor, surgery, or irradiation was the major cause of the damage. Many nerve effects are due to tumor and present before treatment began, but it is impossible to measure the effects of either tumor or treatment on such things as intellect. From this attempt to assess the value of irradiation in the treatment of tumors in children it is concluded that with some neoplasms, radiotherapy has an established place. However, it is necessary to determine the radiosensitivity of the rarer tumors, and in the future efforts should be made to discover why some children's neoplasms are radioresistant and whether results might be improved by a combination of surgery, irradiation, and chemotherapy. (BBB)

250 RADIOTHERAPEUTIC METHODOLOGY. D. Schoen (Universität, Tubingen, Ger.). Med. Welt, 18: 1001-9(May 5, 1962). (In German)

The methods of radiotherapy and their dimensions are discussed. It was concluded that generally, any radiation effects will depend on the time-energy transfer relations, the tissue interaction medium, ionization densities, and sensitivity of the tumor or organ irradiated. (TCO)

251 RADIATION DIAGNOSIS, RADIATION MEDICAL SCIENCE, AND RADIATION PROTECTION 1961. [PART] IV. Friedrich Ekert (Krankenhaus rechts der Isar, Munich). Muench. Med. Wochschr., 104: 92-7(Jan. 12, 1962). (In German)

A review is presented on x-ray diagnostic techniques, contrast media uses, instruments, films, and developers, planning of radiation installations, radiation protection, radiation side-effects, and radiation diagnosis of internal organs. Radiodiagnosis of the skeletal system, with emphasis on systemic and localized disorders, effects of trauma, and skeletal variants is presented. Diagnosis of the vascular and lymphatic system by x ray, and early diagnosis of prostatic cancer by ^{32}P are discussed briefly. Treatment techniques used in radiotherapy of metastatic malignant tumors or noncancerous diseases are described. Several aspects of radiation biology, injuries, hazards, and protection are discussed in terms of their somatic and genetic effects. The relations of some of these considerations to nonmedical uses of radioisotopes are mentioned. References cited, 49. (BBB)

252 NEW DEVELOPMENTS IN THE LOCAL TREATMENT OF TUMORS: PRELIMINARY COMMUNICATION ON THE USE OF A NEW ^{32}P PREPARATION. A. M. Dogliotti and L. Caldarola (Universita, Turin). Panminerva Med., 4: 465-6(Nov. 1962).

Experimental and clinical results are reported on a new ^{32}P-labeled colloidal compound with a high specific activity. A special method is used in its preparation (the details of which are to be described in a later report). Its colloidal particles can vary in size and can be supplied in microspheres from 500 Å to 50 μ diam. It is stable (superior to the chromium radiophosphate preparations in current use) and has a longer decay curve than other preparations (half-life ~14 days) and a homogeneous dispersion. Larger particles (from 5 to 50 μ) can be obtained by fixing the colloidal compound on particles of cationic-exchange resins, which have greater binding power than carbon. This preparation was tested in rabbits, by means of intraportal, intrapienic, intra-arterial, and intralymphatic injections. The first results indicate that it is possible to localize the radioisotope in the desired territory in considerable concentrations. Injection of the isotope into the portal vein showed in animals killed between 4 min and 48 hours after injection that the percentage of radioactivity in the liver over this period remains practically constant at between 70% and 95% of the total amount injected. Radioactivity determined simultaneously in the spleen, kidneys, lungs, brain, and remaining carcass was found to be very slight. After intrasplenic injection, radioactivity in the liver was 6% and in the spleen 1% 4 to 10 min later. In other parts of the body, radioactivity was almost nil. After injection of the radioactive suspension in the femoral artery, measurement of radioactivity in the limb gave percentages varying between 85% and 97% of the total injected with less than 1% in the liver and lung. Results of preliminary clinical application are encouraging. (BBB)

253 TECHNIQUES AND DOSAGE IN TREATMENT OF THYROID CANCER. Keith E. Halnan (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Proc. Roy. Soc. Med., 56: 723-6(Aug. 1963).

Improvement in techniques and dose factors in the use of x rays and ^{131}I to treat thyroid carcinoma are considered, with emphasis on tumor cell destruction and preservation of normal tissues. The radiosensitivity of the normal thyroid is low. Hypothyroidism is uncommon after x-ray therapy alone; one exceptional case, without evidence either of thyrotoxicosis, or of functioning metastases, which is described was still not hypothyroid after, successively, a three-quarter thyroidectomy, radical x-ray therapy, and 60 mC ^{131}I. For partial thyroid ablation for cardiac disease 25 mC ^{131}I is usually needed; for complete ablation 75 to 100 mC is advisable, and the sudden discharge of radioiodine occurs two to five days after the dose, i.e., after a radiation dose of ~40,000 rad. Adenocarcinoma, in general, has low radiosensitivity, but undifferentiated cancer may be less radioresistant and this is probably true with thyroid cancer. In practice, normal tissue tolerance is usually the limiting factor, particularly when considering the volume that needs treatment, sometimes including the spinal cord and almost always the larynx and trachea. An analysis of survival in relation to radiation dose given by radical x-ray therapy is given. Radical treatment was

usually given over three weeks with a nominal tumor dosage of 2500 to 4000 r. The results suggest that volume is more important than high dosage in undifferentiated cases, whereas in differentiated cancer there seems little significant difference. It may be that few of these treatments were at high enough dosage. In Stage 2 cases the dose is 4000 to 5000 rad in three weeks, or 4500 to 5000 in five weeks for field lengths of 8 to 15 cm. When treatment by radioiodine is to be used, ablation of the normal thyroid is an essential first step. First, 75 to 100 mC ^{131}I will be needed for thyroid ablation, and then hypothyroidism occurs in six to eight weeks, when further radioiodine tests should be done to decide whether it is worth giving a treatment dose. Concentration of radioiodine is the important factor, rather than total uptake. A normal thyroid concentrates about 1 to 2% (25 to 50% in 25 g). At this level, β radiation dose would be 31,000 to 62,000 rad/100 mC ^{131}I with an average biological half life of three days, as is common in carcinoma. At a concentration of 0.1%/g the radiation dosage will still be substantial, 3100 rad/100 mC, and this concentration is probably about the lowest worth considering. It is pointed out that, with this concentration, a patient with minimal residual postoperative tumor of 5 g, will only have a 0.5% uptake; and conversely a patient with extensive and large metastases (250 g) will have a 25% uptake. Gamma-ray dosage from ^{131}I is small and not worth considering unless the tumor is large. It is necessary to estimate the maximum safe dose of radioiodine that needs to be given, and three methods for estimating this dose are outlined. (BBB)

254 THE OXYGEN EFFECT IN RADIOTHERAPY. I. Churchill-Davidson (St. Thomas's Hospital, London). Proc. Roy. Soc. Med., 57: 635-8(July 1964).

The relation between the sensitivity of normal and malignant cells to damage by x rays and the amount of oxygen dissolved around them at the time of irradiation is discussed. If a cell is deprived of oxygen, its radiosensitivity may be reduced by a factor of nearly three, but its sensitivity will be increased only very slightly in the presence of excess oxygen. There is unequivocal evidence that solid growing mouse and rat tumors contain a proportion of cells which are anoxic, and there is an accumulating body of clinical experience which indicates that a similar situation exists in many human tumors. Although these anoxic cells form only a very small proportion of the total number of cells in tumors, 1% being an average estimate, they are likely to make all the difference between success and failure to sterilize a tumor by radiotherapy because, with their radiosensitivity reduced by a factor of nearly three, they may survive the largest radiation dose it is possible to give in clinical practice and cause recurrence of the growth. Suggestions on how this oxygen effect can be overcome are offered. Two possible methods are: (1) To improve the oxygenation of the tumor by providing more oxygen. (2) To deprive the whole tumor area of oxygen by cutting off its blood supply and then giving three times the normal radiation dose. A technique is described for irradiating patients while they are breathing high pressure oxygen. The oxygen pressures used are four atm absolute (45 lb/in^2 gauge pressure) for an anesthetized patient, and three atm absolute (30 lb/in^2) for a conscious patient. A maximum irradiation dose of 3500 to 4000 rad in six treatments is given over 18 or 19 days. Preliminary trials, in which half the tumor was irradiated in air and the other half irradiated while the patient breathed high-pressure oxygen, showed recognizably more histologic damage in the half irradiated in oxygen. Analysis of the results on 160 patients (many with advanced disease were selected) showed that 38 (25%) of them had developed metastases outside the treated area and 10 (6%) had developed a second primary tumor. Although not uniform, the overall response to treatment was definitely better than would have been expected from conventional radiotherapy and in 15 to 20% of cases it was dramatically better. Moderate-size tumors with a reasonably good blood supply, which had not caused excessive damage to the normal surrounding structures, showed the greatest oxygen effect. Especially good results were obtained in treating tumors of the tongue, floor of mouth, tonsil, nasopharynx, larynx, and bronchus. Complications included laryngeal cartilage necrosis, which occurred in 21% of patients in whom the larynx has had to be irradiated. In spite of the tumor being sterilized, it was difficult to get tissue defects, caused by massive tumors, to heal; the stroma was damaged by the irradiation and the blood supply much reduced. If tumors above a certain size are to be treated, it may prove necessary to carry out reconstructive surgery soon after radiotherapy is completed. An alternative method may be to give the patient high-pressure oxygen to breathe for several hours daily for weeks after treatment. (BBB)

255 THE SIGNIFICANCE OF RADIOSENSITIVITY OF THE KIDNEY IN RADIOTHERAPY. Peter B. Kunkler (Charing Cross Hospital, London). Progr. Radiation Therapy, 2: 35-41(1962).

Lesions developing as a result of injury to the kidney during radiotherapy are described, and recommendations regarding dosage and technique are made that will lessen such injury. Many reports have appeared which confirm that a dose of about 2300 R to the whole of both kidneys over five weeks or less may induce radiation nephritis. The absence of renal signs and symptoms when the kidneys receive doses below 2000 Rad does not mean that there has been no decrease in renal reserve and, where the requirements for treating the tumor allow, it is preferable to leave kidney tissue unirradiated. Where circumstances demand heavy irradiation of one kidney, as following nephrectomy or with unilateral impairment of renal function, it is particularly important to limit irradiation of the remaining kidney. The feasibility of nephrectomy following mainly unilateral renal x ray damage should be considered. The essentials in planning radiation therapy in the region of the kidneys are discussed. (C.H.)

256 SYSTEMATIC USE OF SEVERAL RADIATION METHODS IN TELECOBALT THERAPY. J. Becker and H. Kuttig (Universität, Heidelberg). Radiol. Austriaca, 13: 7-14(1962). (In German)

The physical properties of ^{60}Co γ radiation for percutaneous radiation treatment are discussed. It has very little effect on skin because of the buildup effect, produces minimal ionization of bone tissue with reduced danger of osteoradionecrosis, and produces a much higher depth dose than conventional x radiation does. It is also easier for the radiologist to use, because the dose administered is not affected much by the bones in the radiation area, the migration of the dose maximum during pendulum radiation is less, and the high depth dose produced during stationary field radiation reduces the number of fields required. On the other hand telecobalt treatments impose a greater responsibility on the radiologist because of the greater difficulty of estimating the depth dose which cannot be observed by any skin reaction. (TCO)

257 FOCAL DOSE IN THE IRRADIATION OF GYNECOLOGICAL CANCERS ACCORDING TO THE METHOD OF THE VINOHRADY FACULTY HOSPITAL IN PRAGUE. I. COMMUNICATION: EFFECT OF THE SLOPE OF THE PELVIS ON THE DOSE DISTRIBUTION. L. Lintner and J. Benes (Faculty Hospital, Prague). Radiol. Austriaca, 13: 65-8(1962). (In German)

The method of transcutaneous x radiation of gynecological cancers used ensures an almost circular homogeneous focal dose with a dia of 14 cm. The method is simple and reproducible. In this method the initial irradiation is made at the juncture of the cranial border of the symphysis with the flexure of the coccygeal bone. At the midpoint of this junction 6 convergent fields are administered in both forward and backward directions. The centers of the radiation fields lie in a zone that is above the cranial border of the symphysis and the flexure of the coccyx. It is perpendicular to the plane of the radiation table. Usually this ideal configuration is never found because of the individual variations in the inclination of the pelvis. Usually the anatomical relations of these landmarks are somewhat shifted. The effects of these shifts on the focal dose were

studied by means of measurements in phantoms. It was found that even when the ventrally and dorsally converging fields were shifted by as much as 4 cm each from the center, the shape of the isodose curves was not changed. It could be concluded that the inclination of the pelvis had practically no influence on the distribution of the focal dose, and was about equivalent to the ideal case obtained when the plane established by the cranial border of the symphysis and the coccyx was exactly perpendicular to the horizontal plane of the treatment table. (BBB)

258 FOCAL DOSE IN THE IRRADIATION OF GYNECOLOGICAL CANCERS ACCORDING TO THE METHOD OF THE VINOHRADY FACULTY HOSPITAL IN PRAGUE. II. COMMUNICATION: EFFECT OF RADIATION ABSORPTION IN THE PELVIC BONES ON THE FOCAL DOSE. L. Lintner and J. Benes (Faculty Hospital, Prague). Radiol. Austriaca, 13: 313-16(1962). (In German)

In order to measure effects of bone absorption of x radiation on the resulting focal dose in the pelvic area, measurements were made in a phantom constructed of a human skeleton and rice. As measured in several radiation fields the dose measured within the phantom was close to 13% less than the theoretical values. The maximum focal dose was also shifted toward the symphysis and was reduced by 20%. The absorption measured in the pelvic bones of the phantom was checked against direct intravaginal measurements in 5 patients. The measured dose was found to be close to 20% less than the theoretical value expected. The values found checked closely with the values found from the phantom. The results of these comparisons indicated that if more penetrating radiation is used the amount of absorption could be considerably reduced. In this way the calculated theoretical dose could be administered. (BBB)

259 FROM X-RAY FLUOROSCOPY TO THE IMAGE INTENSIFIER-TELEVISION COMBINATION. A. A. Zimmer (Roentgeninstitut Aarbergerhof, Bern). Schweiz. Med. Wochschr., 92: 1381-8(Nov. 3, 1962). (In German)

The radiation hazard to a patient is much greater during fluoroscopy than with x-ray photography. A fluoroscopy series requires greater care to ensure protection from radiation, and is tiring both to the operator and to the patient. Adaptation to the fluoroscopic room environment is vital to the success of the study. The value of fluoroscopic procedures is reduced also by the difficulty of discerning fine details with the unaided eye. However, fluoroscopy has many advantages that have led to improved methods for increasing screen light visibility and reducing the large x-ray dose that the patient receives during examination. The equipment used for these purposes is the electron-optical image intensifier combined with a television monitor. This combination permits the physician to obtain a bright, clear fluoroscopic image, with adequate contrast that will permit a more accurate diagnosis to be made without excessive strain on the physician and patient. The picture obtained may be viewed without prior adaptation being required, and the brightness of the monitor permits the examination to be made in subdued light rather than in complete darkness. This will contribute to the reassurance of an anxious patient. In addition, it has an additional advantage when surgical procedures must be carried out simultaneously with the fluoroscopic procedure. Other advantages of this procedure using the image intensifier and television monitor are that smaller details can be recognized, and also that the same picture can be obtained, with, for example, 0.4 ma where 4 ma was required previously. In this way the radiation exposure of patients can be reduced by a factor of 40. There are other additional new fields of application for this type of teleradiodiagnosis. These would involve the use of additional monitors, stereotelevision, or photographic or magnetic picture recording. This would permit small details that would ordinarily be overlooked to be recorded and studied at greater length. (BBB)

260 CALCULATION AND PRINTOUT OF DOSE DISTRIBUTION FOR Co-60 TELETHERAPY WITH AN IBM-1401 DATA HANDLING SYSTEM AFTER EXPERIMENTALLY DETERMINED OUTPUT VALUES. Guenter Schoknecht (Auguste-Viktoria-Krankenhauses, Berlin). Strahlentherapie, 125: 75-90(Sept. 1964). (In German)

Using a special device, experimentally determined dose rate values of fixed fields can be brought into digital form required for the computer program proposed. Fixed fields with the common field sizes at different rotational angles were determined for the Theratron C II irradiation unit. The remeasured tumor-air-ratios agreed with measurements obtained by other authors. The results are plotted as graphs from which values for the different irradiation cases can be rapidly obtained. Using a previously described program, the dose values were calculated with an IBM 1401 computer. The program was modified to print calculated dose values according to their geometric distribution. Body cross section as well as isodoses are plotted in the printing pattern. A complete representation of the dose distribution within a body cross section plane is obtained. The procedure is described using several examples. (auth)

261 GEOMETRICAL BASES FOR CALCULATION OF DOSE DISTRIBUTION IN DEEP THERAPY. A METHOD FOR CALCULATING THREE-DIMENSIONAL BODY CONTOURS IN DATA. Manfred Busch and Joachim W. Woenckhaus (Universität, Freiburg i. B.). Strahlentherapie, 125: 91-101(Sept. 1964). (In German)

A computer program for the calculation of dose distributions, using three dimensional body contours, was developed. Contrary to most of the previous methods, which used a polar coordinate system for measuring body contours, a rectangular three dimensional coordinate system is used for the method proposed. Body contours are approximated by overlapped and inclosed ellipsoids. Thus, simple functions can be obtained for the body surface. An example is given which demonstrates that this model can be used even for complicated contours, such as shoulder-neck-chin-region. (auth)

262 THE USE OF COMPENSATION FILTERS FOR IMPROVEMENT OF DOSE DISTRIBUTION IN THE TELECOBALT THERAPY OF CERVICAL CARCINOMAS. Hans-Joachim Frischbier and Helmut Kuttig (Universität, Heidelberg). Strahlentherapie, 125: 161-72(Oct. 1964). (In German)

The use of compensation filters with telecobalt therapy in combination with radium for improving the dose distribution during irradiation of parametria and pre- and post surgical irradiation of cervical carcinoma is described. A harmonical wedge filter as well as a step filter was used. Advantages of using percutaneous telecobalt therapy alone are discussed. (auth)

263 PROBLEM OF VOLUME AND SMALL-SPACE DOSE DISTRIBUTION IN THE X-RAY IRRADIATION OF UTERINE CARCINOMAS. Karl-Heinz Vogelgesang and Karl Grosse-Holz (Knappschaftskrankenhauses, Recklinghausen, Ger.). Strahlentherapie, 125: 173-90(Oct. 1964). (In German)

An irradiation technique for gynecological carcinoma is reported. Using conventional methods, a homogeneous irradiation of the small pelvis and the upper lymph node groups can be achieved using 10 fixed fields and one convergent field. This method will not limit the use of radium therapy. This method allows irradiation of four centers (uterus, both of the parametria, and aortic lymph nodes) at the same time. Without abandoning the advantages of a relative small space irradiation, a local dose of 3000 R is obtained at the lateral pelvic wall as well as at the splitting point of the arota. Dose distribution was determined by phantom measurements. The relative depth dose at the pelvic wall, related to the surface dose, is 170 per cent. (auth)

264 CALCULATION OF DOSE DISTRIBUTION FOR MULTI-AXIS PENDULUM IRRADIATION USING DIGITAL COMPUTERS. Dieter Schirrmeister and Juergen Richter (Robert-Rössle-Klinik, Deutsche Akademie der Wissenschaften, Berlin and Rechenzentrum des Instituts "Prüffeld für Elektrische Hochleistungstechnik," Berlin). Strahlentherapie, 125: 211-18(Oct. 1964). (In German)

Using average tissue depths instead of average depth

doses, the fundamentals for calculating the dose distribution with a multi-axis pendulum irradiation are given, using digital computers. Special consideration is given to the required coordinate transformation. The method is demonstrated by means of biaxial and fouraxial irradiation technique. (auth)

265 RADIOTHERAPIE DER ERKRANKUNGEN DES NERVENSYSTEMS. (Radiotherapy of Diseases of the Nervous System). Ludwig Psenner and Franz Wachtler. Strahlentherapie, Sonderbaende, 44: 1-152(1960). Munich and Berlin, Urban & Schwarzenberg, 1960.

Physical and technical principles of x-ray and gamma radiotherapy are reviewed. Uses of particle radiation are also considered. Radiation dose, standardization of irradiation methods, dose measurement, general methods for intracranial irradiation and processes in the vertebral canal, biological radiation effects with special regard for the nervous system, and guide lines for studying neoplastic and inflammatory processes after irradiation are discussed. Radiotherapy of endocranial and brain tumors is described, and results are reported for the various types of tumors. Treatment of endocrinic illnesses, dysosteagenetic processes, inflammatory illnesses, various neurological conditions, degenerative sicknesses, and epilepsy using radiation is discussed. Functional radiotherapy and radiation injuries are considered. (M.C.G.)

266 RADIOLOGICAL DIAGNOSTICS AND THERAPY OF BENIGN THYROID DISEASES ESPECIALLY TUMORS. Wolfgang Horst (Universität, Hamburg). Strahlentherapie, Sonderbaende, 49: 6-22(1962). (In German)

Radiodiagnosis of thyroid diseases with the help of radioiodine (multiphase studies, scintigraphy, and hormone load) is discussed. Results of radiotherapy of benign thyroid diseases are also reported. Radiotherapy of struma and toxic adenoma are especially considered. (M.C.G.)

267 THE POSITION AND IMPORTANCE OF CESIUM THERAPY IN THE AREA OF HIGH-VOLTAGE THERAPY. Erich Walter (Siemens-Reiniger-Werke AG., Erlangen, Ger.). Strahlentherapie, Sonderbaende, 49: 142-8(1962). (In German)

On the basis of physical data and the radiophysical data, dose depth curves, absorption ratios, etc., for ^{137}Cs, it was shown ^{137}Cs is inferior to ^{60}Co, but superior to conventional x radiation for radiotherapy at high energies. Cesium therapy is an additional variant in high-voltage therapy and plays a distinguished role in shallow therapy. (tr-auth)

268 POSSIBILITY OF INCREASING DOSE EFFICIENCY BY SELECTION OF THE OPTIMUM FILTER MATERIAL. Hermann Boesche, Johannes Kratsch, and Felix Wachsmann (Universität, Erlangen, Ger.). Strahlentherapie, Sonderbaende, 49: 189-97(1962). (In German)

Investigations were made of usual filter material with regard to the relation of its depressing and hardening equivalents and in order to establish in which voltage region with filters of various materials of equal hardness, the highest dose rate can be obtained. The filter materials were all investigated in the region from 10 to 400 kv. It was found that cellulose in the voltage region from 10 to 25 kv, aluminum from 25 to 50 kv, iron from 50 to 150 kv, and zirconium from 150 upwards at the same hardness gave the same dose rates. Uses of the various filters for various types of radiotherapy and radiodiagnosis are discussed. (M.C.G.)

269 REDUCTION OF RADIATION DOSE IN CLINICAL RADIOISOTOPE DIAGNOSTICS BY USE OF WHOLE-BODY RADIOACTIVITY DETECTORS WITH LIQUID SCINTILLATORS. Hellmuth C. Heinrich (Universität, Hamburg). Strahlentherapie, Sonderbaende, 49: 198-205(1962). (In German)

Reduction of the radiation burden to patients in the diagnostic use of radioisotopes is discussed. Use of a 2-π or 4-π whole-body detector with a liquid scintillator was found to reduce the amount of radiation necessary for counting. Uses in resorption tests, liver function diagnosis, kidney function diagnosis, determination of blood circulation time, and thyroid disease diagnosis are described. (M.C.G.)

270 SELECTIVE ABSORPTION AS THE UNSOLVED PROBLEM IN DOSIMETRY OF LONG WAVELENGTH X RADIATION. Albin Proppe (Universität, Kiel). Strahlentherapie, Sonderbaende, 49: 211-14(1962). (In German)

The important part of the characteristic radiation of anode material in the total radiation from a roentgen soft-beam tube, which in the wavelength region of interest has several absorption edges for biologically important elements (iron, calcium, potassium, chlorine, sulfur, and phosphorus) as well as an increasingly higher linear ion density in the tissue, does not permit a direct inference of the strength of the biological reaction from the doses in R units determined by atmospheric ionization. This is proved using a model. The use of soft-beam techniques in dermatological x-ray therapy therefore requires a revision of previous dosimetry in this region. (tr-auth)

271 THE PROBLEM OF THE "RADIATION PROTECTION RISK" IN "ATTENTION TO ACCOMPLISHMENT OF LEGAL COMPENSATION-RESPONSIBILITIES." Hanno Poppe (Universität, Gottingen, Ger.). Strahlentherapie, Sonderbaende, 49: 256-61(1962). (In German)

Legal aspects of radiation protection risk in radiodiagnosis and radiotherapy are discussed. Liability of the doctor is considered. Test conditions for the insurance of medical radiation risks are described. Examples of additional contributions to radiation risks are discussed. (M.C.G.)

272 RISK-FREE RADIATION INJURY. Guenther Hertel (Universität, Hamburg). Strahlentherapie, Sonderbaende, 49: 262-6(1962). (In German)

Radiation injuries in radiotherapy and radiodiagnosis are considered from the standpoint of liability. Procedure difficulties in putting through authorized claims and deficiencies in the system of social security for the injured are discussed. Methods of insurance, provision, and care are outlined. Protection in the form of private insurance financed by contributions of the patients, supplements to the civil aid measures, and a pooling of the support capacity are considered. (M.C.G.)

273 REGIONAL CHEMOTHERAPY OF HEAD AND NECK TUMORS BY INTRA-ARTERIAL INFUSION TECHNIQUES. Bernard L. Yollick and Donald A. Corgill (Veterans Administration Hospital, Dallas). Texas State J. Med., 59: 423-9(May 1963).

Clinical experience with a new technique of oxygen enhancement of radiosensitivity using intra-arterial hydrogen peroxide is reported. In this method oxygen tension of tumor cells is increased by the intra-arterial infusion of 0.12% H_2O_2. Oxygen tension of the venous blood flowing from the tumor region is increased above normal, and radiotherapy delivered to the patient is definitely enhanced. However, tumor regression over a short-term basis has been shown to be superior to that from radiotherapy alone. The experiences in treating five patients with this technique are described. (TCO)

274 POSSIBILITIES AND LIMITS OF MODERN RADIATION THERAPY. Walter Frommhold and Heinz Braband (Staedtische Auguste-Viktoria-Krankenhaus, Berlin). Therap. Gegenwart, 101: 381-90(Aug. 1962). (In German)

Radiotherapy of malignant tumors has advanced markedly since its inception more than 60 yr ago. Close cooperative efforts and continuous interchanges between the fields of the biological sciences and physics have been extremely productive so far, and will continue to be so in the future. The most important advances of modern radiation therapy have been made possible by development of technical devices and medical use of high energy radiations and corpuscular radiation, such as the betatron, telecobalt sources, or ^{137}Cs teletherapy instruments. The physical differences between these radiation devices establish limitations on their applications, which are discussed. (TCO)

275 RADIOISOTOPE RENOGRAPHY. Chester C. Winter. Baltimore, The Williams and Wilkins Co., 1963. 199p. $9.00.

Research and development of renography are traced, clinical applications and interpretations of the renogram are given, and future possibilities of renography are predicted. Aspects of renography considered specifically are: renal function tests; history and development of renography; the renogram of the normal kidney; test equipment; technique of renography; radioactive test agents in renography; the renogram of obstructive uropathy; the renogram in kidney dysfunction; the renogram in other disease states of the kidney; renography in hypertensive patients; renography in surgery; practical advantages of renography; fallacies regarding the renogram; and future possibilities of the renographic method. (H.M.G.)

CHEMISTRY

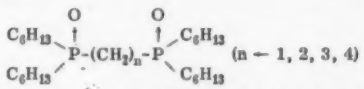
General

276 (BNL-8489) LIQUID FUEL SYNTHESIS USING NUCLEAR POWER IN A MOBILE ENERGY DEPOT SYSTEM. M. Steinberg and M. Eeller (Brookhaven National Lab., Upton, N. Y.). Oct. 1964. Contract [AT(30-2)-Gen-16]. 11p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The production of liquid fuel such as NH_3 or CH_3OH in the field using nuclear power is considered. In the synthesis of CH_3OH, CO_2 is sorbed from air and reacted with electrolytic H_2. The advantages of CH_3OH over NH_3 as a fuel are outlined. A set of requirements is derived for production of 1000 gal/day of CH_3OH, and is shown that 300 psia is an optimum operating point for minimizing sorbent bed size. (D.L.C.)

277 (IS-827) SOLVENT EXTRACTION PROPERTIES OF SOME BIS(DI-n-HEXYLPHOSPHINYL) ALKANES. John Edward Mrochek and Charles V. Banks (Ames Lab., Ames, Iowa). Feb. 1964. Contract W-7405-eng-82. 193p. Dep.; $5.00(cy), 4(mn) OTS.

A general comparison of the solvent extraction properties of some bidentate organophosphorus compounds with the structure



($n = 1, 2, 3, 4$)

is reported. The partition of mineral acids and the solvent extraction of uranium(VI), praseodymium, neodymium, samarium, and thulium from nitrate, chloride, and perchlorate media are considered. The complexing (in solution) of uranium(VI) nitrate by these bidentate ligands and tri-n-octyl phosphine oxide (TOPO) was investigated by means of infrared spectral data, partition studies and molar conductivity and viscosity measurements. Chemical analyses and nuclear magnetic resonance proton spectral data for water-saturated solutions of these organophosphorus compounds in an inert diluent are presented. The bidentate ligands with $n \leq 2$ were found to be powerful extractants of uranium(VI) from perchlorate media in contrast to the ligands with $n \geq 3$ and TOPO. Solvent extraction behavior from nitrate or chloride media was quite similar for all five organophosphorus compounds probably because of the coordinating tendencies exhibited by these anions. As the ratio of ligand to uranium(VI) nitrate approached one for for the bidentate ligands and two for TOPO, highly covalent species were formed as shown by sharp minima in the molar conductance data. Viscosity data appeared to rule out the formation of polymers and thus these data were interpreted as indicating the formation of monosolvated chelate-ring complexes by the four bidentate organophosphorus compounds. Increasing ligand/uranium(VI) nitrate ratios led to the displacement of nitrate groups from the coordination sphere of uranium as shown by the infrared spectra and conductance measurements. The coordination of ligands with $n \leq 2$ appeared to cause the displacement of two nitrate groups from the coordination sphere of uranium while coordination of the compounds with $n \geq 3$ resulted in the displacement of less than two nitrates. In the absence of an aqueous phase the bidentate organophosphorus compounds appeared to form hemisolvated bidentate complexes while TOPO formed a monosolvated complex. Stoichiometric formation did not occur as shown by loading capacity studies but the concentrations did increase with increasing separation between the two phosphoryl groups. Bis(di-n-hexylphosphinyl)methane ($n = 1$) formed a stable monohydrate when solutions of this compound in an inert diluent were equilibrated with water. Nuclear magnetic resonance proton spectra of this complex were interpreted as possibly indicating an intramolecular hydrogen-bonded structure with one water molecule bonded to both phosphoryl oxygens forming an eight-membered ring. The ligands with three and four carbon chain bridges ($n = 3, 4$) appeared to form dihydrates while a ratio of 1.6 water molecules/ligand molecule was found for the ligand with a two carbon chain bridge ($n = 2$). Polymer formation could not be ruled out as a possible explanation of the data on the basis of these investigations. (auth)

278 (ORNL-3679) CHEMISTRY DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING JUNE 20, 1964. (Oak Ridge National Lab., Tenn.). Sept. 1964. Contract W-7405-eng-26. 152p. Dep.; $4.00(cy), 3(mn) OTS.

Research and development are reported on nuclear chemistry, nuclear and inorganic chemistry of special elements, isotope chemistry, radiation chemistry, organic chemistry, chemistry of aqueous systems, electrochemical kinetics and corrosion, nonaqueous systems at high temperatures, chemical physics, and water. Separate abstracts were prepared for each of the ten topics. (J.R.D.)

For abstracts of individual sections see: 279, 280, 347, 348, 417, 429, 865, 930, 962, and 1562.

279 (ORNL-3679(p.19-22)) NUCLEAR AND INORGANIC CHEMISTRY OF SPECIAL ELEMENTS. (Oak Ridge National Lab., Tenn.).

Work was undertaken to develop methods for determining Pa species in HF solutions. The TaF_6^- and TaF_7^{--} ions formed by Ta in HF solutions were identified by comparing the Raman spectra of crystalline $CsTaF_6$ and K_2TaF_7 with spectra of the solutions. The Raman spectra of crystalline Na_3TaF_8 and $(NH_4)_3TaOF_6$ were also recorded. At low HF concentrations two unidentified Ta species appear, one with a Raman line in the Ta–O stretch region and the other with a line in the Ta-fluoride stretch region. The specific activity and half life of ^{99}Tc were redetermined by a liquid scintillation counting technique and found to be 3.75×10^4 dis min^{-1} μg^{-1} and 2.14×10^5 yr, respectively, in good agreement with previous results using 4π beta counting techniques. A crystal-field analysis of the visible spectrum of $ReCl_3$ in HCl showed that the observed absorption bands are consistent with the trivalent Re being in tetrahedral coordination. A prediction of the visible spectrum of the corresponding Te complex is given. (auth)

280 (ORNL-3679(p.94-116)) CHEMICAL PHYSICS. (Oak Ridge National Lab., Tenn.).

Paramagnetic resonance measurements on single crystals of H_2O_2 photolyzed with ultraviolet continued. The most prominent spectrum results from a triplet-state species. Single crystals of D_2O_2 were also studied, and they show the same triplet plus another triplet species not found in H_2O_2. Other less intense spectra are also present. The paramagnetic resonance spectra of rather simple, short-lived organic free radicals were observed in liquids at room temperature during intense uv photolysis. The systems thus far studied are alcohols containing a small amount of H_2O_2. Radicals that were identified are CH_2OH, CH_3CHOH, CH_3COHCH_3, and $CHOHCH_2OH$. Parameters of the spin Hamiltonian for a triplet-state species in gamma-irradiated dimethylglyoxime were ascertained from electron spin resonance measurements of single crystals. These parameters show that the triplet-state species is a pair of coupled doublet-state radicals which had been studied previously. The doublet-state radicals are believed to be formed by the removal of one of the N–O–H hydrogen atoms of dimethylglyoxime by the radiation. The triplet-state species is formed when the removed H atom abstracts an N–O–H hydrogen atom from a neighboring molecule one unit cell distance away in the direction of the crystal a axis. A semiautomatic machine is described which prepares an integrated recording from an existing chart recording. An accuracy of about 2% can be achieved routinely. Apparent molar enthalpies of mixing in the molten LiF–NaF system at 1278°K, observed by high-precision drop calorimetry, show evidence of the presence of solid solutions in the quenched sample mixtures and are therefore in need of

correction by using aqueous solution calorimetry. The unusual behavior of the heat capacity of $ReCl_3$(c) below 50°K was confirmed by additional heat capacity measurements. The behavior is believed to arise from vibrational energy states of the Re_3Cl_9 clusters present in $ReCl_3$(c) rather than from magnetic or electronic excitation phenomena. The thermodynamic properties of $ReCl_3$ from 0 to 300°K are tabulated. The anisotropic temperature factor coefficients derived during refinement of three-dimensional neutron or x-ray Bragg-reflection intensity data define a trivariate normal probability density function for the thermal motion of each atom. The most convenient graphic representation is the thermal-motion probability ellipsoid where the ellipsoid is a surface of constant probability density centered about the atomic site. This tedious drafting problem was automated by using a computer and digital X-Y plotter. The illustrations produced are suitable for journal publication. Stereoscopic pairs of illustrations can also be plotted to aid in the visualization of complex thermal-motion patterns. Preliminary plans are presented for a relatively inexpensive computer-controlled x-ray or neutron diffractometer. A refinement of the crystal structure of α-D-glucose ($C_6H_{12}O_6$) from three-dimensional neutron data was nearly finished. The standard errors of the coordinates are about 0.001 to 0.002 A for the C and O atoms and 0.002 to 0.005 A for the H atoms. The molecular parameters of the molecule are, in general, quite close to those of the glucose moiety in sucrose, but there are some significant differences in C–O bond lengths. The structure of monoclinic K_2NbF_7 was redetermined from three-dimensional neutron diffraction data. The basic correctness of Hoard's structure of 1939 was confirmed. The structural parameters, including anisotropic thermal parameters, are now known to high precision. The Nb–F bond lengths, after correction for thermal motion, range from 1.939 to 1.977 Å. The crystal structure of potassium hydrogen chloromaleate was determined from three-dimensional neutron diffraction data. The anion is nearly planar with an internal H bond of length 2.403 Å. The H atom is apparently situated in the center of this bond. Analysis of three-dimensional x-ray precession data of a crystalline material grown from xenon hexafluoride preparations yielded the monoclinic space group $P2_1/m$, with eight Xe atoms per unit cell. A Patterson synthesis placed these into two regular tetrahedral groups, related by a center of symmetry. A length of 4.19 ± 0.02 Å for the edges of the Xe tetrahedra was obtained. Molecular beam scattering techniques were used to study intermolecular potentials and chemical reactions in a number of systems. Rainbow scattering was observed in the K–Xe system, and the depth of the interatomic potential well was found to be 200 cal. Measurement of the relative total cross section of scattering of K by I_2 and by atomic I indicated that the contribution of electronic exchange to the potential was observable in the total scattering cross section. Work was begun on the measurement of the relative scattering cross sections of H_2 and D_2 in He. Crossed molecular beam techniques were used to study the reaction of K and Cs with Br_2. The angular distribution of the alkali bromide molecules showed that the reaction involved a stripping mechanism (i.e., no activated complex) in which the second Br atom acted only as a spectator particle. A new molecular beam scattering apparatus which utilizes a rotatable four-pole mass filter was designed and constructed. A part of this apparatus was used to study the differential elastic scattering of Cs^+ (2 to 20 ev) from Ar. Good agreement was found with the repulsive part of the theoretical potential. Measurement of the phase shift of a modulated He beam reflected from a heated Pt surface was covered with a low-molecular-weight contaminant. Treatment of the Pt with low pressures of O_2 appeared to remove this contaminant and the reflection patterns observed were sharper than any reported heretofore. Fine structure was observed in these patterns and may be due to diffraction from the surface grating. A comprehensive program for studying atomic readjustment to inner-shell vacancies is centered around the measurement of the relative abundances of ions produced from x irradiation of rare gases. The results were interpreted in terms of Auger cascades and electron shake-off. Molecular gases are also currently being investigated for the consequences of the explosion of highly charged ions. (auth)

281 (PNE-112F(Pt.III)) SHOCK-INDUCED TRANSITIONS. PART III. THEORY AND RESULTS. Marcel W. Nathans (California. Univ., Livermore. Lawrence Radiation Lab.). June 26, 1964. Project GNOME. 48p. Dep.; $2.00 (OTS).

The theory of shock-induced chemical or phase changes is outlined. The formation of diamond, the quartz-coesite transition, and transitions in silicate minerals are discussed. Results are summarized for the experiments on various samples in the Gnome shot; no changes were detected in pyroxenes, olivine, diopside, anorthite, labradorite, albite, leucite, quartz, silica gel, garnets, clay, polyhalite, calcite, dolomite, microcline, grossularite, actinolite, coconino sandstone, enstite, stilbite, and heulandite. Diamond phase was not formed in the various forms of carbon and carbides. (D.L.C.)

282 (RFP-436) MEASUREMENTS OF PLUTONIUM NITRATE SHIPPING SOLUTIONS. J. T. Byrne, R. L. Delnay, W. E. Domning, L. F. Grill, and J. F. Miner (Dow Chemical Co. Rocky Flats Div., Golden, Colo.). Oct. 1, 1964. Contract AT(29-1)-1106. 179p. Dep.; $5.00(cy), 3(mn) OTS.

A study was made of the problems associated with the shipping of plutonium nitrate solutions in order to determine the causes of shipper-receiver differences on the shipments. Solution stability and analytical methods were investigated. It was found that the major cause of shipper-receiver differences is the analytical determination of plutonium in solution. (D.L.C.)

Analytical Procedures

Refer also to abstract 802.

283 (AERE-R-4420) THE SPECTROGRAPHIC DETERMINATION OF SILICON IN CERAMIC MAGNESIUM OXIDE. M. L. Wordingham and M. S. W. Webb (United Kingdom Atomic Energy Authority. Research Group. Chemistry Div., Woolwich Outstation, England). Aug. 1964. 12p. Dep.; $0.50(BIS), 2s. 6d.(HMSO).

Samples of magnesium oxide are converted to a suitable bulk density, finely powdered, and ground with a mixture of silver chloride and strontium fluoride as "carrier" and cobalt oxide as internal standard. The mixture is weighed into anode cups and arced at 14 amp d-c. The spectra are evaluated by non-recording microphotometry. The effective concentration range is 15–200 ppm of silicon in magnesium oxide and the coefficient of variation is 10% for single exposures at the 100 ppm level. (auth)

284 (AERE-R-4615) THE SPECTROGRAPHIC DETERMINATION OF NIOBIUM IN PROTACTINIUM-231. F. T. Birks, A. M. Thomas, and G. W. C. Milner (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Sept. 1964. 19p. Dep.; $0.60(BIS), 3s.(HMSO).

A direct copper spark method has been developed for the determination of the niobium content of protactinium-231 samples. Molybdenum is used as the internal standard and the method is applicable to samples containing more than about 0.15% niobium. For chemically purified protactinium samples containing <0.15% niobium, a more sensitive procedure has been developed. This includes the use of paper chromatography to separate and concentrate the niobium before spark excitation. Any losses occurring in the chemical treatment are corrected for by employing niobium-95 as a radioactive tracer. In this method tantalum is preferred as the internal standard in the spectrographic determination. (auth)

285 (AERE-R-4713) THE DETERMINATION OF NITROGEN IN URANIUM NITRIDES. PART II. G. W. C. Milner, G. Jones, D. Crossley, and G. Phillips (United Kingdom Atomic Energy Authority. Research Group.

Atomic Energy Research Establishment, Harwell, Berks, England). Sept. 1964. 18p. Dep.; $0.60(BIS), 3s.(HMSO).

Application of the Kjeldahl method to the analysis of uranium nitrides in the range of compositions from UN to $UN_{1.7}$ has been investigated. Uranium mononitrides are soluble in hydrochloric acid containing hydrofluoric acid, and the Kjeldahl method is applicable to such solutions. A coefficient of variation of 0.5% has been obtained for the determination of the nitrogen contents of mononitrides, and results agree with those produced by the Dumas method. The higher nitrides ($UN_{1.5}$ to $UN_{1.7}$) proved to be more resistant to solution in mineral acids, and the best solution procedures so far have resulted in some losses of nitrogen taking place. For this type of sample a negative bias of a few per cent has been obtained for the determination of the nitrogen content. (auth)

286 (HW-81746(p.3.14-15)) BACKGROUND REDUCTION IN GAMMA-RAY SPECTROMETRY. R. W. Perkins (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Background reduction of up to one order of magnitude for gamma spectrometry was obtained by a combination of anticoincidence shielding and light pipe shielding of the crystal from its phototubes. (auth)

287 (HW-SA-3721) THE DETECTION OF PLUTONIUM. N. S. Porter (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Sept. 18, 1964. Contract AT(45-1)-1350. 14p. (CONF-761-1). Dep.(mn); $1.00(cy), 1(mn) OTS.

From United States Army Reserve Research and Development Seminar, Pasco, Wash., Oct. 1964.

A brief description is given of several techniques used in industry for detecting plutonium by air monitoring, gamma spectrometry, and x-ray detection. Instruments are also described. (D.L.C.)

288 (LA-3123) DETERMINATION OF YTTRIUM IN TANTALUM–YTTRIUM ALLOYS. K. S. Bergstresser and G. R. Waterbury (Los Alamos Scientific Lab., N. Mex.). June 1964. Contract W-7405-eng-36. 10p. Dep.; $1.00(cy), 1(mn) OTS.

A method is described for the determination of yttrium in tantalum–yttrium alloys that contain from 0.025 to 0.25 percent yttrium. In the analysis hydrofluoric acid is added to alloy samples to dissolve tantalum and convert yttrium to an insoluble fluoride. This yttrium fluoride is separated from all tantalum by centrifuging and then heated to fumes with perchloric acid to remove interfering fluoride ions and obtain yttrium in solution form. Addition of arsenazo I to the borate-buffered yttrium solution produces a soluble, colored yttrium complex that is used for spectrophotometric determination of yttrium. The standard deviation was estimated to be 2 micrograms of yttrium from data obtained in analyzing fifteen samples, each containing 100 mg of tantalum and from 25 to 125 micrograms of yttrium. The method is not specific for yttrium; other elements, particularly rare earth metals, will interfere unless separated by preliminary operations. (auth)

289 (LA-3124) THE SPECTROPHOTOMETRIC DETERMINATION OF MICROGRAM QUANTITIES OF COBALT IN TANTALUM AND PLUTONIUM. T. K. Marshall, J. W. Dahlby, and G. R. Waterbury (Los Alamos Scientific, Lab., N. Mex.). Apr. 1964. Contract W-7405-eng-36. 16p. Dep.; $1.00(cy), 1(mn) OTS.

A sensitive spectrophotometric method was adapted for the determination of trace amounts of cobalt in tantalum and plutonium. The cobalt (2 to 42 micrograms) is complexed with 2-nitroso-1-naphthol and extracted into chloroform from an aqueous sodium citrate solution at pH 4. The extract is washed to remove excess color reagent, and the absorbance is measured at 530 millimicrons. The molar absorptivity of the color comples is 14,300. The relative standard deviation is no greater than 1.5 percent for a single determination of cobalt in the concentration range between 10.0 and 83 parts per million in 500 milligrams of tantalum or plutonium. A positive bias of 4 percent was found at the 4 parts per million level, but no bias existed for concentrations greater than 10 parts per million. Of 37 ions tested, only the ions containing iodine, platinum, or ruthenium caused serious interference, and iodine may be removed by evaporation of the solution to near-dryness with perchloric acid. (auth)

290 (LA-3125) ELECTRON MICROPROBE EXAMINATION OF DELTA-STABILIZED PLUTONIUM. E. A. Hakkila, G. R. Waterbury, and C. F. Metz (Los Alamos Scientific Lab., N. Mex.). Aug. 15, 1964. Contract W-7405-eng-36. 13p. Dep.; $1.00(cy), 1(mn) OTS.

An electron microprobe method was developed for determining the gallium in plutonium stabilized in the delta phase with 0.1 to 2 percent of gallium. Samples are metallographically polished, then ultrasonically cleaned to remove loose particles of plutonium-containing material. Intensities of the Kα x-ray line for gallium, corrected for background, are measured from randomly selected areas of the sample and are compared to intensities measured from pure gallium and a known, homogeneous plutonium–1 percent gallium alloy. The standard deviation of the method is 0.03 and 0.04 percent for analyzing samples containing 0.00 and 1.00 percent of gallium, respectively. (auth)

291 (LA-3134) THE DETERMINATION OF SILICON IN PLUTONIUM METAL AND ALLOYS USING PERCHLORIC ACID DEHYDRATION. Arthur L. Henicksman, Charles T. Apel, William H. Ashley, and Al Zerwekh (Los Alamos Scientific Lab., N. Mex.). Aug. 1964. Contract W-7405-eng-36. 10p. Dep.; $1.00(cy), 1(mn) OTS.

The classical gravimetric method for the determination of silicon, using perchloric acid as the dehydrating agent, has been modified and applied to the determination of silicon in plutonium metal, plutonium silicide, and various plutonium alloys. The sample is dissolved in hydrochloric acid and the silica dehydrated by fuming with perchloric acid. After filtering, the silica is ignited and weighed. After treatment with hydrofluoric acid the residue is weighed, and the loss in weight corresponds to the amount of silica present in the sample. The method has been applied to known mixtures simulating alloys containing silica in amounts from 0.1 to 5.0 percent. The average recovery of the silicon present ranged from about 99 percent in the mixtures high in silicon to about 96 percent in the samples containing the smallest amounts. Relative standard deviations, calculated for a single determination, ranged from about 0.4 percent in samples containing 5 percent silicon, to about 2.0 percent for the low-silicon mixtures. (auth)

292 (NAA-SR-9734) DETERMINATION OF THE WATER CONTENT OF POLYPHENYL COOLANTS. M. A. Rotheram (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Oct. 15, 1964. Contract AT-11-1-GEN-8. 23p. Dep.; $1.00(cy), 1(mn) OTS.

The Karl Fischer Method was investigated for application to the determination of the water content of polyphenyl coolant samples. Two techniques were studied: (1) samples dissolved in pyridine-methanol solvent were titrated directly with Karl Fischer Reagent, and (2) the water was separated from the polyphenyl coolant sample by distillation with pyridine and the water content of the distillate was determined. The two techniques yielded comparable results for liquid polyphenyl coolant samples. For solid coolant samples, the distillation technique gave more precise results. Based on the limited number of samples studied, the precision (standard deviation) of the pyridine distillation technique (and the direct titration technique for liquid coolant samples) is 6 ppm H_2O in the range from 30 to 100 ppm water. The solubility of water in a liquid polyphenyl mixture was measured as a function of water vapor pressure at room temperature. (auth)

293 (NASA-TN-D-2153) DETERMINATION OF LESS THAN 10 PARTS PER MILLION CARBON IN TUNGSTEN. William A. Gordon, Judson W. Graab, and Zita T. Tumney (National Aeronautics and Space Administration, Lewis Research Center, Cleveland). Oct. 1964. 12p. $0.50(OTS).

In the combustion-conductometric method, the smallest detectable quantity of carbon is limited by errors introduced by a spurious carbon blank. Also, the accuracy of

the method for refractory metals is unknown since quantitative calibration is based on recoveries of carbon from steel samples or on organic compounds. Studies of the control of these possible sources of error resulted in establishing conditions whereby carbon concentrations of 4 ppm may be determined with a precision of ±12 percent and an estimated accuracy of ±15 percent relative. These conditions appear to be directly applicable to other metals, including Nb, Ta, Ti, Zr, Cr, and Cu. (auth)

294 (NLCO-914) ABSORPTION CORRECTION TABLES FOR MICROPROBE ANALYSIS. J. W. Colby and J. F. Niedermeyer (National Lead Co. of Ohio, Cincinnati). Oct. 2, 1964. Contract AT(30-1)-1156. 73p. Dep.; $3.00 (cy), 2(mn) OTS.

Absorption correction data are tabulated as a function of mass absorption coefficient in increments of 10 from 0 to 5000 and mean atomic number from 4 to 94. They have been specifically calculated for an accelerating voltage of 20 kv and for an x-ray emergence angle of 52.5°. However, an additional table has been included to enable their use with other emergence angles and/or accelerating voltages. (auth)

295 (NLCO-917) THE CORRECTION FOR FLUORESCENCE BY CHARACTERISTIC RADIATION IN MICROPROBE ANALYSIS. J. W. Colby (National Lead Co. of Ohio, Cincinnati). Oct. 8, 1964. Contract AT(30-1)-1156. 28p. Dep.; $2.00(cy), 1(mn) OTS.

Suggested values are given for the fluorescence yields and the absorption jump ratios. The correction for fluorescence by characteristic radiation has been tabulated, thus simplifying the over-all calculation of the correction. (auth)

296 (NLCO-930) SUMMARY TECHNICAL REPORT FOR THE PERIOD JULY 1, 1964 TO SEPTEMBER 30, 1964. (National Lead Co. of Ohio, Cincinnati). Oct. 20, 1964. Contract AT(30-1)-1156. 21p. Dep.; $1.00(cy), 1(mn) OTS.

Abstracts are presented for the three sections of the report. (N.W.R.)

For abstracts of individual sections see: 297, 298, and 299.

297 (NLCO-930(p.1,1-3)) PREPARATION OF THIN-FOIL SPECIMENS FOR TRANSMISSION ELECTRON MICROSCOPY. M. M. Cook (National Lead Co. of Ohio, Cincinnati).

A rapid and dependable method is described for producing thin-foil specimens of uranium and uranium alloys for electron microscopy. (auth)

298 (NLCO-930(p.2,1-10)) EXAMINATION OF AS-CAST URANIUM–CARBON ALLOYS BY ELECTRON MICROSCOPY. W. A. Althaus, M. M. Cook, and R. J. Bieker (National Lead Co. of Ohio, Cincinnati).

The network phases which are made visible by 1 : 1 aqueous nitric acid etching of uranium–carbon alloys were found by electron microscopy to be composed primarily of uranium carbide. These submicron particles precipitate on either dislocation networks or low index planes. Other data given indicate the mechanism of etching attack on high purity uranium and the growth of the massive primary carbide particles in the uranium matrix. (auth)

299 (NLCO-930(p.3,1-5)) COLOR TECHNIQUE FOR THE IDENTIFICATION OF INCLUSIONS IN URANIUM METAL. E. L. Schaich (National Lead Co. of Ohio, Cincinnati).

By a process of etching and heat tinting it was possible to identify inclusions in uranium by color. Colors could be produced on UC, UH_3, UP, U(CN), and U_6Fe. (auth)

300 (ORNL-P-539) THE RAPID DETERMINATION OF LOW CONCENTRATIONS OF OXYGEN AND HYDROGEN IN ALKALI METALS BY A MODIFIED AMALGAMATION TECHNIQUE. Gerald Goldberg (Oak Ridge National Lab., Tenn.). [nd]. Contract W-7405-eng-26. 11p. (CONF-721-4). Dep.(mn); $1.00(cy), 1(mn) OTS.

From 8th Conference on Analytical Chemistry in Nuclear Technology, Gatlinburg, Tenn., Oct. 1964.

The amalgamation technique involves the addition of mercury to the alkali metal and draining off the resulting amalgam, leaving the unreactive oxide behind which is then determined by titration or flame spectrophotometry. Hydrogen is determined by gas chromatography of the gas evolving during refluxing of the amalgamation. An apparatus was developed which could determine less than 50 ppm O_2 in less than 1 hour, and the method was demonstrated for Na, K, and NaK. (D.L.C.)

301 (RT/CHI(64)-10) DETERMINAZIONE DELL' ACQUA NEI POLIFENILI CON IL METODO DI KARL FISCHER. (Determination of Water in Polyphenyls by the Karl Fischer Method). T. Bazzan, C. Bordonali, C. Patimo, and F. Salvemini (Italy. Comitato Nazionale per l'Energia Nucleare, Rome). May 1964. Dep.

A detailed description of the determination of the water content in polyphenyls is given: two different applications of the K. Fischer method allows one to determine water in the range of 50–100 ppm (direct titration) and in the range of 10–20 ppm (coulometric titration). This last method offers the advantages of a greater sensitivity and speed; on the other hand, it suffers from possible non-homogeneous distribution of the water in the sample to a greater extent than the method based on direct titration where larger samples are required. (auth)

302 (RT/CHI(64)-11) DETERMINAZIONE PER ASSORBIMENTO ATOMICO DI TRACCE DI METALLI IN COMPOSTI ORGANICI. (Determination of Trace Metals in Organic Compounds by Atomic Absorption). C. Bordonali, M. A. Biancifiori, and G. Besazza (Italy. Comitato Nazionale per l'Energia Nucleare, Rome). June 1964. 21p. Dep.

A method is described to determine trace level impurities of Cu, Mn, Fe, Pb, Ni, and Zn in polyphenyls mixtures. This method is suitable to detect metal impurities in the range of 0.5–10 ppm with a standard deviation of 2–4%. (auth)

303 (RT/CHI(64)-13) ANALISI GAS CROMATOGRAFICA QUALITATIVA E QUANTITATIVA DI MISCELE DI TERFENILI COMMERCIALI. (Qualitative and Quantitative Gas Chromatographic Analysis of Commercial Terphenyl Mixtures). N. Basili, C. Bordonali, and C. Patimo (Italy. Comitato Nazionale per l'Energia Nucleare, Rome). June 1964. 23p. Dep.

A method for determining qualitatively and quantitatively biphenyl, ortho-terphenyl, meta-terphenyl, and para-terphenyl contained in polyphenyl mixtures used as organic reactor moderators is described. The standard deviation for a mixture composed of: 11.4% of biphenyl; 33% of ortho-terphenyl, 23.3% of meta-terphenyl, 32.3% of para-terphenyl; corresponds to: 4.5 for biphenyl, 3 for ortho-terphenyl, 1.5 for meta-terphenyl, 2.5 for para-terphenyl. (auth)

304 (TID-7696) PROCEEDINGS OF THE NINTH ANNUAL CONFERENCE ON BIO-ASSAY AND ANALYTICAL CHEMISTRY, OCTOBER 10 AND 11, 1963, SAN DIEGO, CALIFORNIA. (General Atomic Div. General Dynamics Corp., San Diego, Calif.). Contract [AT(04-3)-187]. (CONF-212). 244p. Dep.; $6.00(cy), 6(mn) OTS.

Separate abstracts were prepared for seven of the papers presented. Seven papers were previously abstracted in NSA 18: 133, 165, 1501, 8078, 22882, 29211, and 35407. (C.H.)

For abstracts of individual papers see: 35, 36, 305, 306, 519, 629, and 694.

305 (TID-7696(p.10-31)) THE DETERMINATION OF TECHNETIUM-99 IN URINE. William Fairman and Jacob Sedlet (Argonne National Lab., Ill.).

The increased use of technetium-99 in large quantities has necessitated the development of a procedure for the determination of this isotope in excretion samples. In emergencies or in the known absence of other activities, a rapid separation of this isotope can be effected by co-precipitating the technetium from raw urine with cupric sulfide, mounting the resulting precipitate, and counting in a proportional or Geiger beta counter. For samples where other activities may be present, a procedure was developed

which incorporates liquid scintillation counting as the measuring technique in order to increase the counting efficiency for this low-energy beta emitter. An ammoniacal scavenging precipitation is made in the raw urine. After acidification and the addition of copper(II) carrier to the supernatant, the technetium(VII) is co-precipitated with the copper as sulfide. Dissolution of the sulfide is effected by ammoniacal hydrogen peroxide. After removal of the copper carrier by cation exchange, the technetium is further purified by solvent extraction and anion exchange, followed by determination of the activity in a liquid scintillation counter. (auth)

306 (TID-7696(p.64-86)) URINALYSIS FOR METABOLIZED PLUTONIUM. W. E. Sheehan, W. R. Wood, Jr., and H. W. Kirby (Mound Lab., Miamisburg, Ohio).

A urinalysis procedure which was developed using spiked samples of human urine gave erratic results when it was applied to the determination of metabolized plutonium. Individual samples of human urine were spiked with known quantities of plutonium-239 and thoroughly mixed, H_3PO_4 was added and followed by NH_4OH, which coprecipitated the plutonium with calcium and magnesium phosphates. The plutonium was separated from the natural phosphates by coprecipitation with added cerium carrier at pH 4.5. Plutonium recoveries from the spiked samples were consistently above 90%. However, when human urine known to contain metabolized plutonium was processed by this method, the results were erratic; recoveries ranged from 85% to 6%. On the assumption that the metabolized plutonium was present in the urine either as an organic complex or as a colloid, the urine, as received, was made 1.5M in HNO_3 and heated in a water bath for three hours at 85 to 90°C. The alkaline phosphate procedure was then used. Twenty-nine urine samples from 11 individuals known to be excreting plutonium were processed by the modified procedure. All the supernates from each sample were recombined and reprocessed by a total-ashing procedure. The modified alkaline phosphate procedure gave reproducible results, with recoveries consistently above 85%. It is concluded that a urinalysis procedure developed on the basis of pooled, spiked, or otherwise synthetic samples must be regarded as tentative until it has been applied successfully to samples submitted under field conditions by individuals who are excreting plutonium. (auth)

307 (UJV-1006/64) ACID DETERMINATION IN URANYL SALT SOLUTIONS IN THE PRESENCE OF SOME HYDROLYSABLE COMPOUNDS. M. Talaš (Československá Akademie Věd. Ústav Jaderného Výzkumu, Řež.). [1964]. 18p. Dep.(mn).

The determination is carried out by potentiometric titration of the acid in dimethylformamide solution after uranyl and possibly other cations have been masked in the form of thiocyanate complexes. The method may be used even at a nitric acid concentration of 10^{-3} M, and even in the presence of a hundredfold molar uranyl excess. Th^{4+}, Zr^{4+}, Fe^{3+}, Al^{3+}, Ce^{3+} (as nitrates), Fe^{2+} (as sulfate), Cl^-, and ClO_4^- do not interfere in the determination; higher concentrations of SO_4^{2-} interfere. The method may also be used to determine acid in the organic phase, and by means of back-titration also to determine the acid deficiency in alkalized uranyl nitrate solutions. (auth)

308 ACTIVATION ANALYSIS OF SOILS AND ROCKS IN NORWAY. Per Thoresen (Norwegian Defence Research Establishment, Keller, Norway). Acta Chem. Scand., 18: 1054-8(1964).

A method is described to identify elements giving the greatest contributions to thermal neutron-induced gamma activities. The complex gamma spectrum was analyzed for soils and rocks from different parts of Norway. (auth)

309 PRODUCTION OF X-RAYS IN X-RAY EMISSION SPECTROGRAPHY. P. D. Zemany (Knolls Atomic Power Lab., Schenectady, N. Y.). Am. Soc. Testing Mater., Spec. Tech. Publ., No. 349, 1-16(1963).

The x-ray emission spectrograph and the x-ray emission electron microprobe are two instruments that derive analytical results by interpretation of the characteristic x-ray spectra emitted from specimens examined by them. Various applications of each of these instruments and differences between them, derived chiefly from the different methods of exciting the characteristic x-ray spectra, are described. The phenomena involved in producing the continuous and characteristic spectra by electron bombardment and the characteristic and scattered x rays emitted from a specimen when irradiated by an x-ray beam are described, as well as the characteristics of these primary and secondary x rays. Some details of the requirements and ratings of electron guns for the microprobe and x-ray tubes for the spectrograph are mentioned. (auth)

310 RADIOASSAY OF THIN-LAYER CHROMATOGRAMS: A HIGH-RESOLUTION ZONAL SCRAPER FOR QUANTITATIVE C^{14} AND H^3 SCANNING OF THIN-LAYER CHROMATOGRAMS. Fred Snyder (Oak Ridge Inst. of Nuclear Studies, Tenn.). Anal. Biochem., 9: 183-96(Oct. 1964).

The construction of a high-resolution zonal scraper for rapid and quantitative transfer of small zones (1-, 2-, and 5-mm) of adsorbent from narrow glass plates (2 cm wide) into counting vials for liquid scintillation radioassay is described in detail. Zonal scans made with this scraper are shown for thin-layer chromatograms of an impure tripalmitin-^{14}COOH sample and of a total lipid extract of ^{14}C-lipids from rat bone marrow. The scintillation solvent system described (dioxane–water–naphthalene) deactivates silica, thereby preventing adsorption on particles of silica and self-absorption loss of many polar radioactive compounds. It is shown that silica, iodine, dichlorofluorescein, and rhodamine 6G have no quenching properties in this system, whereas elemental carbon (H_2SO_4 charring) causes severe quenching. (auth)

311 TWO-DIMENSIONAL HIGH-VOLTAGE, LOW-TEMPERATURE PAPER ELECTROPHORESIS OF ^{14}C-LABELED PRODUCTS OF PHOTOSYNTHESIS WITH $^{14}CO_2$. Wolfgang Rohr and J. A. Bassham (Univ. of California, Berkeley). Anal. Biochem., 9: 343-50(Nov. 1964). (UCRL-11343)

The separation of early products of $^{14}CO_2$ reduction during photosynthesis by two-dimensional high-voltage, low-temperature paper electrophoresis is described. Although excellent resolution was obtained under very mild conditions of analysis, no new products were found. (auth)

312 DETERMINATION OF POLYPHENYLS IN WORKING ENVIRONMENTS OF ORGANIC REACTORS BY SPECTROPHOTOMETRIC METHODS. Corrado Testa and Giuseppina Masi (CNEN, Rome). Anal. Chem., 36: 2284-7 (Nov. 1964).

The analysis of air for polyphenyl vapors present as the components of the nuclear moderator-coolants Dowtherm A (diphenyl-diphenyl oxide mixture) and Santowax R (ternary terphenylic mixture) is described. Samples were collected on cellulose powder beds for long sampling periods and on silica gel tubes for immediate controls. The quantitative determination of the total polyphenyl concentration, together with the percentage determination of components, were carried out by ultraviolet spectrophotometry. Qualitative and semiquantitative tests were also devised, based on the use of detector tubes containing silica gel impregnated with concentrated sulfuric acid containing formaldehyde and iron (III). The concentration of polyphenyls in working environments is given according to sampling positions and operation conditions. (auth)

313 SUBMICROANALYSIS BY RADIOCHROMATOGRAPHY. G. A. Welford, E. L. Chiotis, and R. S. Morse (Atomic Energy Commission, New York). Anal. Chem., 36: 2350(Nov. 1964).

A method is described for the simultaneous analysis of Ca, Sr, Ba, Pb, Be, and Zr mixtures by performing paper chromatographic separations prior to radiometric precipitation. Using ^{35}S-labeled sulfates, ^{32}P-labeled phosphates, and improved radiometric techniques, sensitivities as low as 0.0001 μg were achieved. The radiochromatographic technique described is also applicable to many other precipitants such as ^{51}Cr-labeled chromate, ^{44}Ti-

labeled titanate, ^{95}Zr-labeled fluozirconate, ^{14}C-labeled carbonate, ^{35}S-labeled sulfide, and ^{32}P-labeled phosphomolybdate. Therefore, all elements that can be isolated chromatographically can be determined at these low sensitivity levels. (P.C.H.)

314 SPECTROPHOTOMETRIC DETERMINATION OF TRACE AMOUNTS OF ZIRCONIUM, TITANIUM, AND MOLYBDENUM IN TUNGSTEN. Silve Kallmann (Ledoux and Co., Inc., Teaneck, N. J.). Anal. Chem., 36: 2358 (Nov. 1964).

A method is described for determining Zr, Ti, and Mo in W by using ethanol or methanol in a column prior to elution with 8 M HCl. The best method consists of eluting W, Ti, and Zr together with a 60-10 eluent and separating the Ti and Zr from the W on a second column with the additional alcohol. In this way, the subsequent elution on the first column of Mo, Nb, and Ta can be achieved without adverse effects. (P.C.H.)

315 REMOVAL OF RADIOACTIVE ACTINIDES AND LANTHANIDES FROM AQUEOUS SOLUTIONS WITH CALCIUM FLUORIDE PRIOR TO FLAME PHOTOMETRIC DETERMINATION OF LITHIUM. H. Perry Holcomb (E. I. du Pont de Nemours and Co., Aiken, S. C.). Anal. Chem., 36: 2360-1(Nov. 1964).

The Tramex solvent extraction process was used to separate americium and curium from the lanthanide elements. The aqueous feed to the process contains about 11 M lithium chloride. The actinides are extracted into the solvent, which is a high-molecular-weight tertiary amine diluted with diethylbenzene. Because the extraction coefficients of Am and Cm are strongly dependent on the lithium chloride concentration, the lithium concentration in the feed solution must be known to within ±2% for adequate process control. A column of calcium fluoride absorbs trivalent lanthanide and actinide elements, which are the major source of alpha and beta radiation in the feed solution, while lithium is not retained. Thus, the lithium in the column effluent can be analyzed in a normal manner by flame photometry. The results of 12 analyses averaged 10.7 M lithium (97.3% recovery) with a relative standard deviation of 1.7% (n = 12). (P.C.H.)

316 SEPARATION AND DETERMINATION OF TRACE QUANTITIES OF URANIUM IN PRESENCE OF PLUTONIUM. Richard J. Baltisberger (Monsanto Research Corp., Miamisburg, Ohio). Anal. Chem., 36: 2369-70(Nov. 1964).

A rapid and qualitative method for the separation of U and Pu even when there are several thousand times as much Pu as U is reported. Uranium is separated from Pu using tri-n-octylphosphine oxide (TOPO). Small quantities of sulfamic acid, ferrous ammonium sulfate, and sodium fluoride are added to the nitrate media to prevent the extraction of Pu, which is reduced to Pu(III). The separated uranium is then determined spectrophotometrically in the organic phase using 1-(2-pyridylazo)-2-naphthol to develop an intense red complex ion at pH 10 in ethanol – cyclohexane. (P.C.H.)

317 THE PAPER CHROMATOGRAPHIC ISOLATION OF NUCLIDES IN AIR SAMPLES. G. A. Welford and E. L. Chiotis (Atomic Energy Commission, New York). Anal. Chim. Acta, 31: 376-81(Oct. 1964).

A method is outlined for the quantitative transfer of nuclides of strontium, barium, cerium, zirconium, lanthanum, yttrium, and niobium from solution to a paper for chromatographic separation. Carrier quantities of iron are precipitated as the hydroxide from a carbonate solution and filtered directly onto the chromatographic paper. A two-dimensional development is utilized to isolate the individual nuclides. This separation procedure is applied to air dust samples containing nuclear debris. Radiometric determinations may be conveniently made by γ-spectrometric or conventional low-background β-measurements. (auth)

318 AMINE EXTRACTION IN REPROCESSING. C. F. Coleman (Oak Ridge National Lab., Tenn.). At. Energy Rev., 2: 3-54(1964).

A review is presented on recent developments and current status in amine extraction systems as pertinent to their potential use in nuclear fuel reprocessing, including both studies of the extraction systems per se and their adaptation to particular process uses. Proposed chemical flowsheets are cited for a number of processes in an auxiliary to fuel reprocessing. Literature references (143) are arranged so as to facilitate access to previous reviews and bibliographies and to specialized studies of the amine systems. (P.C.H.)

319 METHODS OF HYDROGEN–DEUTERIUM ANALYSIS USED AT SACLAY. E. Roth and J. Ravoire (Centre d'Études Nucléaires, Saclay, France). At. Energy Rev., 2: No. 2, 55-74(1964). (In French)

Methods used for the analysis of deuterium in hydrogen or water are discussed. These include: mass spectrometry, infrared spectrometry, density determination, thermal conductivity, and chromatography in the gaseous phase. These methods all give satisfactory results. (P.C.H.)

320 DEMONSTRATION OF A RADIOMETRIC ANALYSIS APPARATUS OF HIGH SENSITIVITY FOR GAS CHROMATOGRAPHY ELUANTS. M. Guillaume and R. Warin (Université, Liège). Bull. Soc. Chim. Belges, 72: 686-98(Nov.-Dec. 1963). (In French)

The setting up of a radioactivity measurement device of chromatographic gaseous eluates of minute volumes (maximum injection of 0.4 λ) was realized for weak β energy isotopes (^{14}C and ^{3}H). The radiochemical detection apparatus is an electrolytic copper ionization chamber. Measurement of the current is made by means of a vibrating-reed electrometer. The electronic stability of the apparatus is satisfactory, and the background due to α's is limited to 10-15 discontinuities an hour. The elution of high boiling point compounds is feasible by heating the ionization chamber and extension device which permits the thermic isolation of the detection chamber. The sensitivity of the whole reaches 1,000 dpm ± 500 with $^{14}C(C^{*}H_3OH)$ and 15,000 dpm with $^{3}H(C_2H_5CH_2^{*})$. (auth)

321 DETERMINATION OF MAGNESIUM IN NODULAR CASTINGS BY ACTIVATION ANALYSIS USING HIGH-ENERGY DEUTERONS. P. De Bruyne and J. Hoste (Rijksuniversitet, Ghent). Bull. Soc. Chim. Belges, 72: 761-75 (Nov.-Dec. 1963). (In French)

Small amounts of magnesium confer valuable properties on nodular cast iron. Ordinary chemical and spectrographic methods for determining magnesium in iron are not satisfactory for concentrations below 0.1%, which is the range of interest in the case of cast iron. The possible application of activation analysis techniques to this problem is reported. It appears that a short bombardment with deuterons of 12 Mev will produce an easily detectable amount of ^{22}Na which will be a measure of the magnesium content of the sample. The iron of the sample itself may be used as an internal monitor through the $Fe(d,\alpha)Mn$ reaction. After correction for the decay of the 6-day Manganese-52, the ratio of the ^{22}Na activity to the ^{54}Mn activity is directly proportional to the magnesium content of the iron. In order to measure the sodium and manganese activities, a method for separating them from iron, cobalt, and other elements was developed. The procedure studied was based on the use of an anion exchange resin. (auth)

322 SPECTROPHOTOMETRIC DETERMINATION OF TRACE OF CHLORINE IN URANIUM BY EXTRACTION METHOD. Tadao Hattori, Toshiaki Kuroha, and Seiji Shibuya (Furukawa Electric Co., Tokyo). Bunseik Kakaku, 13: 853-6(Sept. 1964). (In Japanese)

A method for the determination of chlorine involving the copper diethyldithiocarbamate-benzene extraction of silver after an addition of silver nitrate to a nitric acid solution of pH 1.0 ~ 2.0 containing Cl^{-} was applied to the analysis of uranium metals. Two grams of uranium metal were dissolved in nitric acid with a little silver nitrate. The excess acid was evaporated, and the solution of pH 1.1 ~ 1.8 was let stand for about an hour with phenolphthalein, then transferred in a separatory funnel and extracted with a copper-diethyldithiocarbamate–benzene solution. The amount of chlorine was obtained from the increase in the absorbance at 435 mμ. The lower limit of determination was 1 ppm Cl^{-}. The determination was disturbed by Hg^{2+}, Pd^{2+}, Ag^{+}, I^{-},

and Br^-, which, however, are usually absent in uranium metals. (auth)

323 DIRECT COMPLEXOMETRIC DETERMINATION OF ZIRCONIUM USING PYROCATECHOL VIOLET. V. Baran and M. Tympl (Inst. for Nuclear Research, Czechoslovak Academy of Sciences, Rez). Collection Czech. Chem. Commun., 29: 2250-2(Sept. 1964). (In German)

A precise and rapid method for the complexometric determination of zirconium with pyrocatechol violet was developed for the purpose of studying zirconium hydrolysis. The method can be used for determinations in solutions of different acidity. (tr-auth)

324 CHEMICAL ANALYSIS OF RADIOACTIVE MATERIALS IN WATER. T. F. Craft, T. L. Erb, and D. F. Hill (Georgia Inst. of Tech., Atlanta). J. Am. Water Works Assoc., 56: 1357-68(Oct. 1964).

Methods for the chemical analysis of water supplies for radioactive materials such as ^{90}Sr, ^{89}Sr, ^{134}Cs, ^{137}Cs, ^{131}I, rare earths, ^{140}Ba, ^{144}Ce, ^{106}Ru, ^{103}Ru, ^{95}Zr, ^{95}Nb, ^{204}Tl, and ^{32}P are discussed. (P.C.H.)

325 A METHOD TO DETERMINE THE ISOTOPIC COMPOSITION OF ALPHA-EMITTING THICK LAYERS. A. L. Dekker, H. R. Kelijn, and J. J. Went (Technische Hogeschool, Delft, Netherlands). Kerntechnik, 6: 407-9 (Sept. 1964).

The isotopic composition of heavy elements such as plutonium and uranium can be determined by alpha spectroscopy. A method of performing such an analysis without using thin sources and a complete alpha-spectrometer is described. For this purpose the energy distribution of alpha particles coming from a thick layer is discussed in addition to the number of particles absorbed in the media between the source and the detector. Some results are presented for ^{234}U in uranium samples of different enrichments. (auth)

326 PYROLYTIC GRAPHITE CUP AS BOTH VESSEL AND ELECTRODE FOR MICRO REDOX AND ACID-BASE POTENTIOMETRIC TITRATIONS. Paul F. Thomason (Oak Ridge National Lab., Tenn.). Microchem. J., 8: 234-40(Sept. 1964). (ORNL-P-121)

A potentiometric titration vessel of pyrolytic graphite is described for use in microtitrations, which are usually performed with colored indicators. The vessel also serves simultaneously as the indicator electrode, the reference electrode being an in-burette platinum wire. Thus, the need for internal electrodes is eliminated. The vessel has been used satisfactorily in both manual and automatic titrations. (auth)

327 THE 1:2 YTTRIUM–THORON CHELATE AND ITS APPLICATION TO YTTRIUM ANALYSIS. Satendra P. Sangal (Univ. of Allahabad, India). Microchem. J., 8: 304-12(Sept. 1964).

Formation of a pink-colored chelate (λ_{max} = 500 mμ) of yttrium with thoron at pH 4.0 and 25°C is reported. The ratio of yttrium to thoron as determined spectrophotometrically using several methods is 1:2. The chelate is stable between pH 3.0 and 6.5. The value of log K as determined by different methods is 8.6 ± 0.3. The system adheres to Beer's from 0.23 to 16.0 ppm of yttrium. The sensitivity of the system is 0.042 γ per square centimeter. (auth)

328 p-NITROBENZENE AZOCHROMOTROPIC ACID AS A CHROMOGENIC REAGENT FOR THE PHOTOMETRIC DETERMINATION OF SCANDIUM AND YTTRIUM. Satendra P. Sangal (Univ. of Allahabad, India). Microchem. J., 8: 313-16(Sept. 1964).

Scandium and yttrium give a pinkish violet chelate with chromotrope 2B (CTB) in the ratio of 1:1. Suitable conditions for the determination of the metals in micro amounts, i.e., range of adherence to Beer's law, effect of pH on the stability of the chelate, effect of excess of reagent, sensitivity, and interference due to foreign ions were worked out. (auth)

329 DETERMINATION OF COPPER, MANGANESE, AND COBALT IN URANIUM SOLUTIONS BY NEUTRON ACTIVATION. H. Marchart and F. Hecht (Universität, Vienna). Monatsh. Chem., 95: 742-9(1964). (In German)

The ppm contents of Cu, Mn, and Co in uranium solutions (50 mg U/ml) were determined by means of activation analysis. Uranium was separated before irradiation by TBP extraction. The mixture of gamma activities was separated by multichannel pulse-height analysis. The results of 10 to 13 parallel determinations showed that the method is suitable for routine analyses in reactor operation. (tr-auth)

330 NOTES ON THE ISOTOPE ANALYSIS OF URANIUM WITH THE HYPEAC AND THE AUTOMATIC ELECTRONIC INTEGRATOR. Ch. A. Berthelot (Central Bureau for Nuclear Measurements, Euratom, Geel, Belg.). Nucl. Instr. Methods, 30: 274-6(Nov. 11, 1964).

Systematic errors in intensity measurements of the homologous lines of uranium isotopes can be avoided, by using a sonic leak device to perform a linear scanning of the Fabry-Perot rings as a function of time and by integrating the areas under the lines with an automatic electronic integrator. Faster analysis and higher precision are obtained. The two techniques are discussed. (auth)

331 DETECTION OF GUNPOWDER RESIDUES BY NEUTRON ACTIVATION ANALYSIS. R. R. Ruch (General Atomic Div., General Dynamics Corp., San Diego, Calif.), V. P. Guinn, and R. H. Pinker. Nucl. Sci. Eng., 20: 381-5(Dec. 1964).

Virtually all U. S. and foreign revolver ammunition contains an antimony compound in the primer of the bullet, and many also contain a barium or a lead compound. Studies show that, in all revolver ammunition examined to date, readily measurable traces (of the order of 0.2 μg) of antimony are deposited on the back of the hand each time the gun is fired. In many cases, easily measurable traces of barium are deposited, (~1 μg), while in certain cases, copper is also found (0.2 to 3.0 μg). A satisfactory neutron-activation procedure has been worked out which involved: careful removal of any possible residue from the hand; activation of the removed material for 30 to 60 minutes in the TRIGA reactor at a thermal neutron flux of 1.8×10^{12} n/sec cm^3; radiochemical separation of any induced 2.8-day ^{122}Sb, 84-minute ^{139}Ba, and 12.8-hour ^{64}Cu activities wtih carriers; and multichannel gamma-ray spectrometry identification and quantitative determination of each activity. Possible means of removing powder residues from skin have been explored, and several satisfactory methods are available. The residues have not been examined for lead because of the relatively poor sensitivity for lead (~10 μg) and because the 3.3-hour ^{209}Pb induced activity is a pure beta emitter. The Sb, Ba, and Cu are separated from the salty solution obtained from the hand, and from one another, by postirradiation carrier precipitation of barium as $BaSO_4$, extraction of antimony as $SbCl_5$ with isopropyl ether (followed by conversion to aqueous Sb^{3+} and precipitation as elemental Sb for counting), and precipitation of copper as CuSCN. In these separations the yields are high and the procedure is rapid. The detection limits, for a one-hour irradiation at 1.8×10^{12} flux, are 0.01 μg Sb, 0.05 μg Ba, and 0.001 μg Cu. (auth)

332 NOMOGRAPHIC INTERPRETATION METHOD IN THE X-RAY FLUORESCENCE ANALYSIS OF THREE-COMPONENT SAMPLES. Bohdan Dziunikowski (Academy of Mining and Metallurgy, Krakow). Nukleonika, 9: 829-34 (1964).

Matrix-effects in the x-ray fluorescence analysis are discussed. In the three-component samples these effects may be avoided by means of the nomographic method of interpretation of the experimental data. The basis of this procedure and the possibilities of its application to the determination of zinc and iron content in ore samples were discussed. (auth)

333 STUDIES IN THE SEPARATION AND ESTIMATION OF TITANIUM USING VANILLIN AS AN ANALYTICAL REAGENT. B. D. Jain and J. J. Singh (Univ. of Delhi). Proc. Indian Acad. Sci., Sect. A, 60: 85-9(Aug. 1964).

Studies showed that when an aqueous or alcoholic solution of vanillin is added to Ti solution at pH 3.5-6.5, an insolu-

ble yellow titanium-vanillin complex is immediately formed and on ignition the complex gives TiO_2, which can be weighed. Since vanillin does not form any insoluble complex at pH 3.5-6.5 with Cu(II), Ni(II), Zn(II), Mn(II), Co(II), Cr(III), V(V), Mo(VI), W(VI), U(VI), and trivalent rare earths, Ti was separated from about ten times the quantity of these ions and determined gravimetrically without any modification of the method described for Ti alone. (P.C.H.)

334 DETERMINATION OF URANIUM IN FLUORIDE–CHLORIDE SOLUTIONS. P. N. Palei, A. A. Nemodruk, and P. Yu. Deverdeeva. Radiokhimiya, 6: 459-63(1964). (In Russian)

A method was developed for rapid determination of small amounts of uranium in solutions containing large amounts of fluoride and chloride. The uranium, in amounts from 0.05 to 9.00 mg/l, was extracted with tri-n-butyl phosphate diluted with toluene (20% TBP). Aluminum nitrate was used as both a complexing agent for the fluoride and a salting-out agent. The extracted uranium was re-extracted into an aqueous phase with a 5% aqueous sodium binoalate solution, and the uranium in the strip solution was determined photometrically with Arsenazo III in the presence of 6N nitric acid. For uranium concentrations of 0.05 to 0.5 mg/l the error was 20%, but for higher concentrations it was only 10%. A determination requires from 8 to 10 minutes. Temperature changes within the limits of 15 to 30°C did not affect the results significantly. The method was tested with artificial solutions containing other ions, e.g., besides F and Cl, there were Fe(III), Na, Si, NH_4, PO_4, and SO_4. The TBP-toluene reagent was washed with 5% soda solution and water prior to being used. (TTT)

335 ANALYTICAL TECHNIQUES FOR DETERMINING THE COMPOSITION OF NIOBIUM STANNIDE. K. L. Cheng and Eugene P. Bertin. RCA Rev., 25: 379-92(Sept. 1964).

Chemical and x-ray spectrometric methods have been developed for analyzing Nb_3Sn. In the chemical methods, niobium is determined as niobium pentoxide, Nb_2O_5, after volatilizing the tin as its bromide, or it may be determined as peroxyniobate complex with hydrogen peroxide; tin is determined iodometrically. The x-ray spectrometric method employs a ratio method, in which the net intensities of x-ray spectral lines of niobium and tin are measured and their ratio calculated. The x-ray method is particularly useful in analyzing Nb_3Sn-coated metal ribbon and ceramic plates. (auth)

336 SOME EUROPIUM AND HOLMIUM COMPOUNDS. P. Spacu, Silvia Plostinaru, and Elena Antonescu (Research Inst. for Inorganic Chemistry, Bucharest). Rev. Roumaine Chim., 9: 405-10(June-July 1964). (In German)

The synthesis of some Eu and Ho compounds with mono- and dibasic organic acids is reported. The application of the corresponding salts of the chloro- and bromomandelic acids for the separation and quantitative determination of Eu and Ho is discussed. (tr-auth)

337 SPECTROPHOTOMETRIC DETERMINATION OF PRASEODYMIUM AND NEODYMIUM IMPURITIES IN CERIUM PREPARATIONS. P. M. Nikonov, V. T. Mishchenko, and N. S. Poluektov (Inst. of General and Inorganic Chemistry, Academy of Sciences, Ukrainian SSR). Zavodsk. Lab., 30: 1055-7(1964). (In Russian)

Direct and differential spectrophotometry were used for determining small quantities of praseodymium and neodymium in cerium solutions. The praseodymium was determined using the absorption spectrum at 444 mμ and neodymium at 522 or 742.5 mμ. Maximum error was 5.3 to 10%. (tr-auth)

338 DETERMINATION OF RADIATION YIELDS OF GASEOUS PRODUCTS BY GAS CHROMATOGRAPHY. Z. Kecki (Inst. of Nuclear Research, Warsaw). p.431-6 of "Radiation Chemistry." Budapest, Publishing House of the Hungarian Academy of Sciences, 1964.

A gas-chromatography method was developed for radiolytic gas-product analysis. The sampling device fulfills the three following conditions: introduction of the total amount of gas from an irradiation cell into the column, including that dissolved in the solution; elimination of air leaking from the surrounding atmosphere into the system; and method of ensuring continuous and constant rate of carrier gas flow through the column. (M.C.G.)

339 COMPUTER INTEGRATED ACTIVATION ANALYSIS. John W. Nostrand, Jr. and Henry H. Kramer (Union Carbide Corp., Tuxedo, N. Y.). New York, Instrument Society of America, 1964, Preprint 2.4-2-64, 8p. (CONF-701-8)

From Instrument Society of America 19th Annual Instrument-Automation Conference and Exhibit, New York, Oct. 1964.

A computer-integrated system for processing large numbers of activation analysis samples on a routine basis was developed. The primary objective of the system design is to minimize possible errors and reduce the cost per analysis. The system and the special equipment developed for use with it are described. (auth)

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Refer also to abstract 961.

340 (HW-81746(p.3.120-3)) ELECTRON PARAMAGNETIC RESONANCE LINE SHAPE. W. D. Felix (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

A linear approximation, which combines Gaussian and Lorentzian forms, was applied to the calculation of electron paramagnetic resonance (EPR) line shape. The approximation was applied to an EPR signal generated by DPPH. (auth)

341 (HW-81746(p.4.12-15)) KINETICS OF A REPLACEMENT REACTION. L. L. Ames, Jr. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). (HW-SA-3054)

Kinetics of the replacement type of chemical reaction were studied in a "shallow bed" apparatus. A proposed kinetic model agreed quite well with experimental kinetic results. Replacement type reactions were found to be apparently diffusion controlled. The replacement of gypsum to form barite by a $BaCl_2$-bearing solution, or the reaction $CaSO_4 \cdot 2H_2O + BaCl_2 \rightarrow BaSO_4 + CaCl_2 + 2H_2O$ was chosen for study as typical of the replacement type reaction taking place in the soil. (auth)

342 (HW-81746(p.4.67-71)) PARTICLE DEPOSITION AND RETENTION IN VERTICAL CONDUITS. G. A. Sehmel and L. C. Schwendiman (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Available experimental data relating to particle deposition were evaluated in an effort to establish agreement with a theoretical model or to develop a correlation more accurately disclosing the relationship of the deposition constant to the several variables. The data lend support to a theoretical model proposed; however, the precision of the data is such that critical comparison cannot be made. A parameter grouping was found with which the deposition constant could be better correlated. The parameter group was dominated by the reduced stopping distance term, S^+, used in the theoretical model. The empirical factor by which S^+ was adjusted resulted in the better correlation. A possible trend to higher than predicted deposition was indicated for very low values of reduced stopping distance, S^+. (auth)

343 (HW-81746(p.4.73-5)) PARTICLE DEPOSITION IN 90° TUBE BENDS. A. K. Postma and L. C. Schwendiman (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

The turbulent deposition of particles in 90° tube bends was measured for several flow rates and particle sizes. The bends were formed to an inside radius of 3.8 or 11 cm, in 1.01 cm inside diameter aluminum tubing. Deposition

was found to be highly significant (up to 75%) for 7-μ particles. Particles of 2-μ size were not significantly deposited. Deposition increased about linearly with air flow. Effects of particle density were not determined. The spinning disc aerosol generator was used. (auth)

344 (MLM-1191) SOLUBILITY OF PLUTONIUM COMPOUNDS. Joseph S. Griffo, Willard B. Brown, and Frank D. Lonadier (Mound Lab., Miamisburg, Ohio). July 16, 1963. Contract AT(33-1)-Gen-53. 40p. Dep.; $2.00(cy), 1(mn) OTS.

Solubility data for plutonium compounds are compiled from the literature. Classes of plutonium compounds include those of carbon, the halogens, nitrogen, chelates, oxygen, phosphorous, and sulfur. Miscellaneous compounds and complex compounds of plutonium are included. (auth)

345 (NAA-SR-9161) REPROCESSING OF URANIUM CARBIDE BY A NITRIDE–CARBIDE CYCLE. II. KINETICS OF NITRIDE CONVERSION TO CARBIDE. L. A. Hanson (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Oct. 15, 1964. Contract AT(11-1)-Gen-8. 31p. Dep.; $2.00(cy), 1(mn) OTS.

The reconversion of uranium nitride-carbon mixtures (obtained by reacting UC with nitrogen) to uranium carbide has been investigated as one step in a nitride-carbide cycle for UC fuel reprocessing. Reaction rates were determined by measuring the evolution of nitrogen from samples heated in vacuum in a thermogravimetric balance. The reaction of U_2N_3 + C occurs in two steps; by decomposition to UN, then by conversion to UC. The kinetics of the decomposition of uranium sesquinitride, without carbon present, to uranium mononitride was studied for comparison with the U_2N_3 + C decomposition. Comparison of the results indicate the sesquinitride containing carbon decomposed at a much lower rate with a higher activation energy. The activation energies for the reactions studied were (1) 90.6 ± 11.8 kcal/mol for the decomposition of U_2N_3 + C to UN + C by a linear rate law, (2) 64.4 ± 7.7 kcal/mol for the decomposition of U_2N_3 to UN based on a linear rate law, and (3) 31.3 ± 1.1 kcal/mol for conversion of UN + C to UC by a parabolic rate law. (auth)

346 (ORNL-3676(p.167-76)) PURE MATERIALS PROGRAM. (Oak Ridge National Lab., Tenn.).

The program is concerned with the development of improved techniques of initial purification, crystal growth, and final assay as required for the production of research-quality specimens of immediate and long-range interest. RESEARCH MATERIALS INFORMATION CENTER. The purpose and present status of the Research Materials Information Center are discussed. GROWTH OF SINGLE-CRYSTAL HgS. Mercuric sulfide was purified by fractional sublimation, and several methods of crystal growth are being investigated. GROWTH OF SINGLE-CRYSTAL CdTe. A study was made of the problems of growing single crystals of CdTe, and several ingots of ~80 g each were made from reagent-grade Cd and Te using Stockbarger's method of crystal growth. MAGNETIC SUSCEPTIBILITY OF Er_2GeMoO_8. Determination of the temperature dependence of the susceptibility of Er_2GeMoO_8 indicated no evidence of ferromagnetism. The data suggest that spin interactions are small and are of an antiferromagnetic nature. MAGNETIC SUSCEPTIBILITY OF Cu_2O. Measurements of the magnetic susceptibility of CuO_2 between 3 and 300°K were performed to determine whether the concentration of divalent copper ions could be determined accurately, and to see whether this concentration was consistent with the relation between oxygen pressure and electrical conductivity at high temperature. The results were inconsistent, suggesting that the number of paramagnetic centers observed at low temperature is affected by factors other than the oxidation of the copper by ambient oxygen at high temperature. POTASSIUM CHLORIDE SINGLE CRYSTALS. A reliable method for producing large quantities of starting material for the KCl pulling apparatus was developed, and several single crystals grown from this material were furnished to interested scientists for research purposes. Research is being conducted into the effects of furnace parameters on the properties of the KCl crystals produced. ANALYSIS FOR TRACE AMOUNTS OF LEAD IN KCl SINGLE CRYSTALS. Two essentially nondestructive methods are discussed for obtaining estimates of the amount of Pb in "pure" KCl single crystals down to concentrations below 1 Pb atom per 10^9 K sites. These methods may be used to replace the expensive and time-consuming atomic absorption spectroscopy technique. (auth)

347 (ORNL-3679(p.60-83)) CHEMISTRY OF AQUEOUS SYSTEMS. (Oak Ridge National Lab., Tenn.).

Measurements of the emf of the cell Pt–D_2 (p) |DCl (m)| AgCl, Ag were used to determine the thermodynamic properties of DCl solutions in D_2O as well as the standard potential of the cell to 225°C. The standard potential was found to be lower in the deuterated system than in the corresponding protonated system and the difference became greater the higher the temperature. Activity coefficient behavior in the two systems is consistent with a lower value of the dielectric constant of D_2O at all temperatures. As judged from the variation of activity coefficients with temperature and concentration the difference in the dielectric constant values appears to go through a minimum at about 100°C. Four methods for inverting large symmetric positive definite matrices were compared. These are the Gauss-Jordan, Choleski, congruent transformation, and rank annihilation methods. An attempt has been made to consider the effects of both condition and order of the matrix to be inverted on the closeness of the computed inverse to the exact inverse. Each method was programmed in IBM 7090 FORTRAN II (version 2) using only single-precision arithmetic. Then the error indicators were computed using double-precision arithmetic so that the latter calculation was not a limiting factor. It was found that any one of the methods is satisfactory for a well-conditioned least-squares matrix of order 10 to 30. However, when the matrix becomes ill-conditioned then the Gauss-Jordan method appears to be superior. An improved cell assembly for the standard Cary model 14 spectrophotometer provides for routine measurements of fluid and frozen samples from –80 to 280°C and 0 to 2000 psia. It operated flexibly and trouble-free for more than 100 runs in studies with a number of pure solvents. Seven of nine principal bands which occur in CO_2 in the condensed states between 1.19 and 1.66 μ were identified. The effects of temperature were measured in a frozen sample from –80°C and 13 psia to the freezing point (–56.6°C and 75 psia), in the liquid from the freezing point to the critical point (31.1°C and 1072 psia), and in the gas from the critical point up to 65°C and about 2000 psia. From equilibrium ultracentrifugation, acidity measurements, and comparison of Raman spectra of solutions and solids of known structure, it is concluded that the main polyanionic species formed on addition of acid to tungstate solutions (up to 1.5 moles of acid per mole of WO_4^{2-}) are $HW_6O_{21}^{5-}$, $W_{12}O_{41}^{10-}$, and $W_{12}O_{39}^{6-}$. Equilibrium ultracentrifugation and comparison of Raman spectra indicate that the species $Ta_6O_{19}^{8-}$ predominates in basic Ta(V) solution. Evaluation of equilibrium ultracentrifugation for determination of activity coefficients in three-component aqueous solutions was completed; it appears that the technique may be of value in some of such cases. A general treatment for the electrostatic potential of a water molecule led to the result that, energetically at least, H-bonded structures in liquid water can be compatible with the hydration requirement for small positive ions. Apparatus for the rapid high-precision measurement of the densities of aqueous solutions was completed. Preliminary measurements on NaCl solutions gave excellent agreement with previous work. The osmotic coefficients of the pure Li, Na, K, and Cs salts of p-ethylbenzene sulfonic acid (p-EBS) were measured as a function of concentration at 25°C by the isopiestic vapor pressure method. p-Ethylbenzene sulfonic acid is the monomer unit of the Dowex 50 cation exchange resins and, as such, is expected to be a useful model compound. At any given concentration in the range studied, the osmotic coefficients of the alkali-metal salts of p-EBS follow the order Li > Na > K > Cs, which is the usual sequence for most alkali-metal salts. The ionic selectivities observed with polystyrene sulfonic acid cation exchangers (i.e., Dowex 50) also follow

this trend (e.g., Cs is preferred over Na, etc.). Selectivity coefficients and heats of exchange were measured for the exchange of Li^+ and Cs^+ on a lightly cross-linked polymethacrylic acid type cation exchanger. The thermodynamic quantities calculated at 25°C for the uptake of the preferred ion (Li^+) are $\Delta F^\circ = -107$ cal, $\Delta H^\circ = +374$ cal, and $\Delta S^\circ = +1.6$ eu. Spectrophotometric measurements made on a liquid cation exchanger, prepared by dissolving dinonyl naphthalene sulfonic acid in toluene, and on a cross-linked polystyrene sulfonate exchanger after equilibration with solutions of Fe(III) in concentrated LiBr or HBr solutions showed the presence of the tetrahedral anion $FeBr_4^-$. The heats of dilution of polystyrene sulfonic acid and of its Li, Na, K, and Cs salts were measured. Initial concentrations ranged from 0.04 equiv/kg H_2O to 12 equiv/kg with the final concentration about 1×10^{-3} equiv/kg. Ion exchange studies in both dilute and concentrated HCl and $HClO_4$ solutions were continued. Cation exchange behavior was summarized in two periodic tables which were published. Distribution coefficients for cation exchange in 9M HCl–$HClO_4$ mixtures are given as a function of the HCl fraction for a large number of elements showing an enormous variability in adsorbability which can form the basis of numerous separations. Activity coefficient ratios $\Gamma = \gamma_{M(x)}/\gamma_h$ of HCl and $HClO_4$ were found to be approximately unity in the acid concentration region of 1 to 16M. A large difference in adsorbability of In(III) in HBr from that in HCl is discussed. Work continued on the development of a general separations scheme for the elements based principally on ion exchange. Several examples of cation and anion exchange methods are mentioned, which include separation of trace amounts of Np and Nb from macroamounts of Zr, separation of U, Np, and Pu from each other and from many nonadsorbable elements, the recovery of UX_1 (^{234}Th) from uranyl nitrate solution, and others. (auth)

348 (ORNL-3679(p.117-26)) WATER RESEARCH PROGRAM. W. H. Baldwin, M. D. Danford, Sheldon Datz, et al. (Oak Ridge National Lab., Tenn.).

Hyperfiltration by membranes was studied, especially the behavior of a cellophane-g-polyacrylic-acid membrane. Equipment was developed for rapidly evaluating membranes. A mathematical analysis was carried out for a model membrane to elucidate the effects of differences in diffusion rates of solute and solvent in the membrane and of differences in the distribution of the two components between solution and membrane phases. The effects of the dielectric constant difference on hyperfiltration was investigated. Equipment for determination of self-diffusion and tracer diffusion coefficients in solution was assembled, and results for several typical cases are reported. Activity coefficients of salts in water mixtures of glycol, glycerol, and their acetates were studied. In an investigation of the effect of salts on the miscibility gap in the glycerol triacetate–water system, a large salting-in effect was observed which can lead to complete miscibility on addition of salts such as perchlorates, thiocyanates, iodides, and salicylates. Other water-organic solvent mixtures were studied. Special glass electrodes were evaluated for use in the determination of free energies of salts in aqueous and mixed aqueous-organic solvent systems. Calculation of vapor pressures of sea salt solutions based on NaCl osmotic coefficient data and comparison with experimental measurements is discussed. Studies of the adsorption and ion exchange behavior of a variety of inorganic materials were continued, with emphasis on MgO, La_2O_3, Bi_2O_3, and sulfides, and also on adsorption properties of oxides with respect to sulfides. The calculation of polarization in porous electrodes is discussed, as are differential capacity measurements on such electrodes, which are of interest for various applications. (auth)

349 (ORNL-P-542) CALORIMETRIC INVESTIGATION OF THE THORIUM OXIDE–WATER INTERFACE. H. F. Holmes, E. L. Fuller, Jr., and C. H. Secoy (Oak Ridge National Lab., Tenn.). [nd]. Contract W-7405-eng-26. 24p. (CONF-771-1). Dep.(mn); $1.00(cy), 1(mn) OTS.

From 19th Annual Calorimetry Conference, Washington, D. C. and Bethesda, Md., Oct. 1964.

A calorimeter for the precise determination of heats of immersion in solid-liquid systems has been developed. The all metal calorimeter is of the isothermal jacket type. The temperature sensing element is a thermistor whose resistance is continuously measured by a circuit consisting of a Mueller bridge, a high gain breaker-amplifier, and a recorder. Energy equivalents of the measured resistance changes were determined by electrical calibration. For fast reactions the calorimeter has a useful sensitivity of about 0.002 cal. The calorimeter is capable of handling five samples for a single assembly of the apparatus. Performance of the calorimeter and utility of the results are demonstrated with selected data obtained on the thorium oxide–water system. (auth)

350 (ORNL-P-573) USE OF NEGATIVE SORPTION IN STUDIES OF ION FIXATION BY HYDROBIOTITE. Donald G. Jacobs (Oak Ridge National Lab., Tenn.). [1964]. Contract W-7405-eng-26. 19p. (CONF-770-1). Dep.(mn); $1.00(cy), 1(mn) OTS.

From Proceedings of the Clay Mineral Society, Madison, Wis., Oct. 1964.

The exclusion of anions relative to tritiated water from the negatively charged interlamellar spacing of hydrobiotites having a limited degree of lattice expansion, permits measurement of the interlamellar volume. Measurement of the changes in the interlamellar volume and in the exchange capacity when hydrobiotite lattices are collapsed by potassium treatment or expanded by treatment with sodium tetraphenyl boron provides a means for estimating the distribution of the surface charge densities of these interstratified minerals. In the hydrobiotite sample studied (Zonolite from Traveler's Rest, South Carolina), the biotite fraction was estimated to have a surface charge density of $2.0 \pm 0.14 \times 10^{-7}$ meq cm^{-2} and the vermiculite fraction $1.5 \pm 0.51 \times 10^{-7}$ meq cm^{-2}. The charge density, and its relative distribution, was reflected in the tendency of these mineral fractions to collapse upon potassium treatment and to entrap trace concentrations of cesium in the interlayer spacing. (auth)

351 (RT/CHI(64)-14) A NEW METHOD FOR THE PREPARATION OF URANIUM(IV) SOLUTIONS. G. Cogliati, R. De Leone, and R. Lanz (Italy. Comitato Nazionale per l'Energie, Rome). June 1964. 11p. Dep.(mn).

A catalytic reduction of $UO_2(NO_3)_2$ to $U(NO_3)_4$ with yields in excess of 99% has been developed. Diluted solutions (up to 0.2M) of uranyl nitrate are readily reduced at room temperature and atmospheric pressure; for higher concentration the reduction is carried out under pressure. The major advantage of this method is that of providing an easy one-step way to produce highly pure uranium(IV) nitrate, practically free from U (VI). It must be noted that catalytic reduction can be easily obtained also in organic solutions (ketones, TBP, alkylethers), which gives a ready supply of concentrated organic U (IV). (auth)

352 (UCRL-11584) RATES OF LIGAND EXCHANGE ON METAL COMPLEXES MEASURED BY NUCLEAR MAGNETIC RESONANCE RELAXATION TIMES (thesis). Elaine Carol Blatt (California. Univ., Berkeley. Lawrence Radiation Lab. and California. Univ., Berkeley. Dept. of Chemistry). Aug. 1964. Contract W-7405-eng-48. 131p. Dep.(mn); $4.00(cy), 3(mn) OTS.

A study of the ferric chloride system, from very low chloride ion concentrations to highly concentrated HCl, comprises a major part of this work. NMR relaxation times of both ^{17}O and ^{35}Cl nuclei in conjunction with temperature studies have provided information on quantities involving the rates of water-water exchange, chloride-chloride exchange, the replacement of water molecules by chloride ions, and vice versa from the ferric chloride complexes. Electron paramagnetic resonance studies have aided in elucidation of the mechanism of relaxation and in the definition of species in solution. Insight about the mechanism of the substitution and the exchange reactions from the complexes has been gained in these studies. Qualitative results from preliminary investigations of the water exchange rates are presented from ^{17}O resonance measurements in the following aqueous systems: ferric-

thiocyanate, ferric-fluoride, nickelous-chlorice, nickelous-thiocyanate, nickelous-sulfate, and nickelous-ammonia. (auth)

353 (UCRL-11645) USE OF THE PROGRAM "EQUATION OF STATE 1964" (FORTRAN II). Otto Redlich (California. Univ., Berkeley. Lawrence Radiation Lab.). Sept. 1964. Contract W-7405-eng-48. 14p. Dep.; $1.00(cy), 1(mn) OTS.

ES64 calculates the compressibility factor, the heat content, the entropy, and the fugacity coefficient for a pure substance, and the same mean quantities and the individual fugacity coefficients for a mixture from an empirical equation of state. (auth)

354 (UCRL-12051-T) THE ANALYSIS OF DIFFUSION DATA. David Y. F. Lai (California. Univ., Livermore. Lawrence Radiation Lab.). Aug. 27, 1964. Contract W-7405-eng-48. 11p. (CONF-691-3). Dep.(mn); $1.00(cy), 1(mn) OTS.

From Conference on Fusion of Body-Centered Cubic-Materials, Gatlinburg, Tenn., Sept. 1964.

A discussion is presented of some of the possible experimental errors in tracer diffusion studies using the sectioning and residual counting technique. The errors include heat-up time, incorrect area measurement, counting errors, and incorrect reference plane. The effects of these errors on the results are described. (D.L.C.)

355 (JPRS-26877) PRODUCTION AND PROPERTIES OF RARE EARTH ELEMENTS. Translation of two articles from "Redkozemel'nye Elementy" (a publication of the Institute of Geochemistry and Analytical Chemistry imeni V. I. Vernadskii, Academy of Sciences USSR, Moscow, 1963). 48p. (TT-64-51134) $2.00(OTS).

The two translated articles deal with the preparation and properties of carbides, nitrides, and silicides of some of the lighter rare earths. Separate abstracts were prepared for both articles. (D.L.C.)

For abstracts of individual papers see: 356 and 357.

356 (JPRS-26877(p.1-24)) PRODUCTION AND PHYSICAL-CHEMICAL PROPERTIES OF RARE EARTH CARBIDES AND NITRIDES. Rare-Earth Elements. G. V. Samsonov, T. Ya. Kosolapova, M. D. Lyutaya, and G. N. Makarenko. (A translation)

Conditions of obtaining the carbides of Sc, Y, and La the nitrides of Sc, Ce, and La were studied together with some of their properties. (D.L.C.)

357 (JPRS-26877(p.25-47)) PRODUCTION AND PROPERTIES OF SILICIDES OF SOME RARE EARTH ELEMENTS. G. V. Samsonov, V. S. Neshpor, and Yu. B. Paderno. (A translation)

The reactions of the oxides of La, Ce, Y, Nd, Gd, and Sc with silicon in vacuum at high temperatures were investigated. The formation and some of the properties (structure, hardness, stability, and electric properties) of the silicides are discussed. (D.L.C.)

358 (ORNL-tr-201) FLUORITE-TYPE STRUCTURAL PHASE MODIFICATIONS IN SYSTEMS HAVING A ZIRCONIUM OR HAFNIUM OXIDE BASE. Jean Lefevre. Translated by A. L. Monks (Oak Ridge National Lab., Tenn.), from Ann. Chim. (Paris), 8: 117-49(1963). Dep. (mn); $5.60(fs), $1.82(mf) JCL.

A study was made of various structural modifications of fluorite and relationships with apparent scheelite or Mn_2O_3 structures in ZrO_2– or HfO_2-base systems. Discontinuous and continuous deformation of the fluorite lattice was studied. The systems that were studied included the HfO_2–GeO_2 system and mixtures of ZrO_2 with GeO_2, Yb_2O_3, SiO_2, TiO_2, SnO_2, CeO_2, ThO_2, HfO_2, Gd_2O_3, Nd_2O_3, Sm_2O_3, Y_2O_3, La_2O_3, and Sc_2O_3. (D.L.C.)

359 (UCRL-Trans-1117(L)) OSCILLOGRAPHIC BEHAVIOR AND DETERMINATION OF RUTHENIUM AND OSMIUM. Premyzl Beran, Milos Burian, and Jan Dolezal. Translated for Univ. of California Lawrence Radiation Lab., Livermore, from J. Electroanal. Chem., 4: 105-15 (1962). 34p. Dep.(mn); $3.60(fs), $1.22(mf) JCL.

A brief review is given of the oscillopolarographic behavior of Pt, Pd, Rh, and Ir. An experimental study was made of the oscillopolarographic behavior of Ru and Os in different base electrolytes. Depolarization potentials, Q quotients, and sensitivity values were measured for the detection of both metals. The detection of Os in presence of platinum metals is considered. (D.L.C.)

360 THICKNESS MEASUREMENT OF POLYMER FILMS FOR INFRARED SPECTROMETRY BY BETA-RAY ABSORPTION. ANALYSIS OF ETHENE-PROPENE COPOLYMERS. Th. A. Veerkamp, R. J. De Kock, A. Veermans, and M. H. Lardinoye (Central Lab., Staatsmijnen in Limburg, The Netherlands). Anal. Chem., 36: 2277-8 (Nov. 1964).

Determination of the thickness of films for infrared spectrometric examination may be accomplished in several ways. In the method described, use is made of β absorption. The method has several advantages over the conventional procedures for thickness determination. Since there is no mechanical contact between the measuring device and the sample, the thickness of rubber films can be measured without difficulty. The effective optical thickness is determined, so that the method is applicable to films having a rough surface; knowledge of the density of the film material is superfluous. The relative error in the determination of the thickness does not exceed 1%. (auth)

361 NICOTINYLHYDROXAMIC ACID CHELATES OF URANIUM AND TITANIUM(IV). Ronald Rowland and C. E. Meloan (Kansas State Univ., Manhattan). Anal. Chem., 36: 2376(Nov. 1964).

The formation of uranium and titanium (IV) complexes with nicotinylhydroxamic acid was studied. Titanium (IV) formed a yellow solution over the pH range 3 to 9 when mixed with nicotinylhydroxamic acid with a pH of 9 providing the maximum absorption. The absorption maximum occurred at 380 mμ. The method of continuous variation indicated a 4:1 (ligand to metal) complex at pH 8 at 380 and 500 mμ. Uranium (UO_2^{2+}) formed a yellow solution over the pH range 3 to 11 with the region 6 to 8 the most favorable for the complex formation. Continuous variation studies at 380 and 440 mμ showed a 2:1 chelate at pH 7. At more acidic pH's the chelate formed a pink color. No solvent was found that would extract the chelates. (P.C.H.)

362 THE COMPOSITION OF THE ZIRCONIUM-ARSENAZO COMPLEX. Hiroshi Onishi and Hitoshi Nagai (Japan Atomic Energy Research Inst., Tokyo). Anal. Chim. Acta, 31: 348-51(Oct. 1964).

A detailed spectrophotometric study indicated that at pH 1.3, 1.7, and 3.5 the complex is formed by one mole of zirconium reacting with one mole of arsenazo (R), giving the empirical formula ZrR. (P.C.H.)

363 NEW MODIFICATIONS OF Nb_2O_5. H. Schaefer, F. Schulte, and R. Gruehn (Universität, Munster, Ger.). Angew. Chem. Intern. Ed. Engl., 3: 511(July 1964).

Nb_2O_5 migrates towards the coldest part of a temperature gradient during the endothermic equilibrium reaction: $Nb_2O_5(s) + 3\ NbX_5(g) \rightleftharpoons 5\ NbOX_3(g)$ (X = Cl, Br, or I). By variation of temperature and pressure, especially in the system X = Cl, three modifications (P–, B–, and N–Nb_2O_5) were obtained as well-formed crystals besides the forms known earlier (H–Nb_2O_5 and M–Nb_2O_5). To ensure that the Nb was present to a very high extent in the oxidation state 5, chlorine was added to the reaction tube (1 atm at room temperature). All the Nb_2O_5 modifications transported in this way were colorless, with the exception of the B-form, which was obtained under these conditions with a pale blue color and a composition corresponding to $NbO_{2.48}$. These modifications were mostly formed simultaneously, but usually apart from each other and in such large crystals that they could be easily isolated. P–Nb_2O_5 formed colorless prisms or plates, and contained <0.01% Cl. On annealing amorphous $Nb_2O_5 \cdot nH_2O$ containing 8% HCl, crystalline P–Nb_2O_5 (+T–Nb_2O_5) resulted. B–Nb_2O_5 could be separated as pale blue or colorless plates, which were often over 5 mm in size and contained <0.01% Cl. B–Nb_2O_5 (+T–Nb_2O_5) was obtained from NbO_2 crystals with a low iodine content by igniting them in air; no macroscopically

recognizable B-crystals resulted, however. N–Nb_2O_5 occurred as colorless crystalline needles with 0.1% Cl. The product contained appreciable amounts of SiO_2, but whether this was included in the lattice is not yet known. Nothing is yet known about the thermodynamic stability of the new modifications. The T-modification and its precursor, designated as TT–Nb_2O_5, were also obtainable by transport, but not as perfect crystals. (BBB)

364 ANNUAL REVIEW OF PHYSICAL CHEMISTRY. H. Eyring, C. J. Christensen, and H. S. Johnston, eds. Ann. Rev. Phys. Chem., 15: 1-577(1964). Palo Alto, Calif., Annual Reviews, Inc., 1964.

Topics covered in this review include: thirty years of atomic chemistry, Berkeley radiochemistry, fast reactions in solution, the theory of liquids and dense gases, solutions of nonelectrolytes, cryogenics and helium three, the solid state of intermetallic compounds, surface chemistry, chemical and electrochemical electron-transfer theory, electron spin resonance, microwave spectroscopy, quantum theory of atoms and molecules, optical rotation, quantum processes in photosynthesis, high-pressure chemistry, nucleic acids, statistical mechanics, contractile processes in fibrous macromolecules, thermochemistry and bond dissociation energies, solutions of electrolytes, and high-resolution nuclear magnetic resonance. Separate abstracts were prepared for 6 of the 21 papers. (M.C.G.)

For abstracts of individual papers see: 11, 365, 366, 367, 1436, and 1486.

365 FAST REACTIONS IN SOLUTION. G. G. Hammes (Massachusetts Inst. of Tech., Cambridge). Ann. Rev. Phys. Chem., 15: 13-30(1964).

Research on fast reactions in solutions is reviewed. Protolytic and hydrolytic reactions, electron transfer reactions, metal substitution reactions, radiation chemistry reactions, and biological reactions are discussed. (M.C.G.)

366 ELECTRON SPIN RESONANCE. D. Kivelson and C. Thomson (Univ. of California, Los Angeles). Ann. Rev. Phys. Chem., 15: 197-224(1964).

Electron spin resonance spectroscopy is reviewed with emphasis on $S = \frac{1}{2}$ systems. The higher spin systems are included for organic molecules only. Topics covered include: line shapes; relaxations; theoretical work on spin densities; theoretical work on g-factors; electron spin resonance of hydrocarbon radicals, anions, cations, nitrogen-containing radicals, and radicals containing other metallic elements; irradiation studies by electron spin resonance; and triplet and higher multiplet states. (M.C.G.)

367 HIGH RESOLUTION NUCLEAR MAGNETIC RESONANCE. David M. Grant (Univ. of Utah, Salt Lake City). Ann. Rev. Phys. Chem., 15: 489-528(1964).

Developments in theory and uses of nuclear magnetic resonance are reviewed. Topics covered include: instrumental developments, spectral interpretation, double irradiation techniques, spin relaxation, nuclear spin-spin interactions, chemical shift parameter, and applications of high-resolution nuclear magnetic resonance. (M.C.G.)

368 TRANSPORT CROSS SECTION FOR A CUTOFF COULOMB POTENTIAL. Kurt Suchy (Universität, Marburg, Ger.). Beitr. Plasmaphysik, 4: 71-110(1964). (In German)

The velocity-dependent and velocity-averaged transport cross sections, which appear in the kinetic theory of gases for large and weak deviations from thermodynamic equilibrium, were calculated for a Coulomb potential that is constant outside an "action sphere" around a collided particle. In the limiting case of large relative speeds they have the usual logarithmic factor; for small relative speeds the "action sphere" gives the same results as a rigid sphere for repulsion as well as for attraction. The applicability of the calculated transport cross sections to various relaxation and transport problems is described. (auth)

369 THE IONIZATION METHOD OF MEASURING ELECTRIC SURFACE POTENTIALS BY APPLICATION OF THE ^{239}Pu ELECTRODE. B. Kamieński and J. Czarnecki (Inst. of Physical Chemistry, Krakow and Jagiellonian Univ., Krakow). Bull. Acad. Polon. Sci., Ser. Sci. Chim., 12: 407-11(1964).

Developments in the use of ^{239}Pu electrode are described. By applying strong sources some undesirable effects connected with distance are practically eliminated, and the time necessary to give the full deflection of the electrometer varies by hardly 3.5 sec for a 2 mm and about 6 sec for 15 mm distance. Thus despite varying the distance of the Pu electrode from 2 mm to 15 mm the potential is kept constant. The electric surface potential of benzoic acid solutions in 0.1M KCl was measured as a function of concentration and pH for the purpose of checking the reliability of the results obtained when using the ionization method, in comparison with the dynamic jet method. It was found that the results obtained by the ionization method were shifted towards higher potentials in comparison with those obtained by the dynamic jet method. The results obtained by applying a static surface lie above those obtained by applying a flowing surface. (P.C.H.)

370 PREPARATION AND MAGNETIC SUSCEPTIBILITY OF URANIUM TRIFLUORIDE. Hoang Nguyen-Nghi, Albert-José Dianoux, and Hubert Marquet-Ellis (Centre d'Études Nucléaires, Saclay, France). Compt. Rend., 259: 811-13(July 27, 1964). (In French)

The molar magnetic susceptibility of UF_3 was measured from 20 to 450°C. It follows the Curie-Weiss law with a magnetic moment $\mu = 3.66 \pm 0.014$ μ_B per ion of uranium and a Weiss constant $\Delta = 98 \pm 2.8$°K. Chemical analysis, x-ray diffraction, and study of the magnetic susceptibility show that the wet-method preparation does not lead to uranium trifluoride. (tr-auth)

371 NEW HALOURANATES AND DIURANYL TETRAHALIDES OF POTASSIUM. Jacques Lucas (Universite de Paris, Rennes, France). Compt. Rend., 259: 817-19 (July 27, 1964). (In French)

Hydrogen bromide gas reacts with potassium uranates prepared by dry methods; in all cases there is substitution of a single oxygen atom by two bromine atoms. On the contrary, the action of HBr on the diuranate prepared by wet methods leads to the diuranyl tetrabromide $K_2U_2O_5Br_4$, and thereby to the mixed halogen complex $K_2U_2O_5Cl_2Br_2$ and the two halogeno-diuranates $K_2U_2O_5OCl_2$ and $K_2U_2O_5OBr_2$. (tr-auth)

372 COMPOUNDS OF THE Th_3P_4 TYPE FORMED BETWEEN RARE-EARTH SELENIDES AND ALKALINE-EARTH SELENIDES. Sayed Mehdi Golabi, Jean Flahaut, and Louis Domange (Université, Paris). Compt. Rend., 259: 820-2(July 27, 1964). (In French)

In the systems formed between rare-earth selenides L_2Se_3 and the selenides MSe of alkaline-earth metals, large regions of homogeneity of the type Th_3P_4 exist. These regions are comprised between the L_2Se_3 and ML_2Se_4 compounds for M = Sr with L = La to Gd, and for M = Ba with L = La to Nd. They are more limited with M = Ca for which the definite compound CaL_2Se_4 does not exist. (tr-auth)

373 PRACTICAL CONSEQUENCES OF THE CHOICE OF THE THEORY OF LIMITATION OF THE SUM OF ELECTRONIC STATES ON CALCULATION OF THE THERMODYNAMIC PROPERTIES OF PARTIALLY IONIZED HYDROGEN. Pierre Fauchais and Numa Manson (Université de Paris, Poitiers, France). Compt. Rend., 259: 1023-6(Aug. 3, 1964). (In French)

The thermodynamic properties (electron concentration, enthalpy, and entropy) of the system formed of electrons and neutral and ionized hydrogen atoms comparable to a perfect gas mixture in thermodynamic equilibrium, were calculated by taking account of five of the theories of limitation of the sum of electronic states. At temperatures from 8000 to 25,000°K and pressures from 0.01 to 70 atm, one of the theories, in which some iterative calculations can be neglected, led to results whose relative uncertainty was less than several percent. (tr-auth)

374 THE INTERACTION OF Nd_2O_3 WITH WATER. V. B. Glushkova, E. K. Keler, and Yu. G. Sokolov (Gre-

benshchikov Inst. of Silicate Chemistry, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 158: 151-4(Sept. 1, 1964). (In Russian)

The behavior of the A- and C-forms of neodymium oxides was followed by varying the relative humidity from 25 to 95%. At 35°C the A-form of Nd_2O_3 is stable with respect to water vapor, but the C-form actively absorbs water vapor and is converted to the hydrate $3Nd_2O_3 \cdot 2H_2O$. At temperatures of 90 to 100°C, an equilibrium is attained that is independent of relative humidity with the C-form of Nd_2O_3 going to $3Nd_2O_3 \cdot 2H_2O$ and the A-form of Nd_2O_3 going to $Nd_2O_3 \cdot 3H_2O$. On heating the C-form of neodymium oxide in a current of moist argon, the sample begins to gain weight at 50–60°C due to the formation of a hydrate having the composition $3Nd_2O_3 \cdot 2H_2O$, which breaks down above 300°C with the evolution of water and the formation of the C-form. The compound $3Nd_2O_3 \cdot 2H_2O$ can be formed again on cooling the C-form in a current of gas containing water vapor. The conversion of the C-form to the A-form is actually the breakdown of a compound containing water. The compound $Nd_2O_3 \cdot 3H_2O$ breaks down to the hydrate $Nd_2O_3 \cdot H_2O$ at 350–400°C, which in turn breaks down above 450°C to the C-form of neodymium oxide, which is a hydrate having the composition $3Nd_2O_3 \cdot H_2O$. The C-form evolves water at a high temperature of 800–1000°C to give a hexagonal neodymium oxide (A-form). Infrared analysis showed that the water is present in the various compounds in the form of hydroxyl groups. (TTT)

375 THE SYNTHESIS OF NEW RARE EARTH SILICATES. N. A. Toropov and I. A. Bondar (Grebenshchikov Inst. of Silicate Chemistry, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 158: 173-5(Sept. 1, 1964). (In Russian)

Developments in the field of rare earth silicate chemistry are reviewed by stages. The first stage involved the investigation of phase diagrams in binary, $Re_2O_3-SiO_2$ systems. The second stage was a study of the mutual solid solutions between isostructural, rare earth silicates; the third stage was a study of the phase diagrams of systems involving rare earth silicates and alkali or alkaline earth silicates. A special study was made of liquid phases in two- and three-component silicate systems with rare earths. The fifth stage was the synthesis of the rare earth silicate single crystals and a study of their properties. The divalent rare earth silicates were investigated. Thus, three types of europium silicates were synthesized: the oxyortho compound $Eu_2O_3 \cdot SiO_2(Eu_2O[SiO_4])$, the ortho-2-compound $Eu_2O_3 \cdot 3SiO_2(Eu_4[SiO_4]_3)$, and the diorthosilicate compound $Eu_2O_3 \cdot 2SiO_2(Eu_2Si_2O_7)$. These compounds are analogs of compounds in other systems, which are described. The compound $Eu_2O_3 \cdot SiO_2$ (1:1) melts without decomposition at 1980 ± 30°C. The compound $2Eu_2O_3 \cdot 3SiO_2$(2:3) melts without decomposition at 1950 ± 30°C, and is stable from 1650 to 1950°C. The compound $Eu_2O_3 \cdot 2SiO_2$ (1:2) melts at 1760 ± 30°C with decomposition to $2Eu_2O_3 \cdot 3SiO_2$ and a liquid. Single crystals of $La_2O[SiO_4]$, $Yb_2Si_2O_7$, and $Y_2O[SiO_4]$ were grown and photographed. (TTT)

376 THE MECHANISM FOR THE COPRECIPITATION OF MICROAMOUNTS OF YTTRIUM WITH POLYVALENT METAL HYDROXIDES. N. B. Mikheev and L. M. Mikheeva (Moscow State Univ.). Dokl. Akad. Nauk SSSR, 158: 440-1(Sept. 11, 1964). (In Russian)

The coprecipitation of carrier-free ^{90}Y with $Fe(OH)_3$ or $Zr(OH)_4$ was found to take place by means of electrostatic physical adsorption. Over a definite range of pH, the following relationship was observed: $[x/(a-x)]^{0.33} = \alpha - \beta + \gamma$ pH. Here a is the total amount of microelement in the system, and x is the amount of microelement carried by the precipitate. The terms α, β, and γ are constants. On precipitating carrier-free ^{90}Y from an acid solution with NH_4OH, it was found that the distribution of ^{90}Y between the solution and solid [$Fe(OH)_3$ or $Zr(OH)_4$] obeyed the above relationship. (TTT)

377 ABSORPTION AND FLUORESCENCE OF EUROPIUM(III) IN AQUEOUS SOLUTIONS. P. K. Gallagher (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Chem. Phys., 41: 3061-9(Nov. 15, 1964).

Absorption, fluorescence, and excitation spectra of aqueous solutions of europium(III) perchlorate, chloride, nitrate, ethylenediaminetetraacetate, and diethylenetriaminepentaacetate were investigated. The latter three anions readily form complexes and were examined over a range of concentrations. The organic anions particularly, which are strong chelating agents, cause a general intensification of the spectra, shift to longer wavelengths, and increased crystal field splitting. No transfer of energy was observed from the ligand to the europium ion. Effects of changes in pH were determined and correlated with the weakly acidic nature of these chelates. Factors are discussed that lead to the hundredfold increase in some fluorescence after chelation without the benefit of energy transfer. The spectra are discussed with reference to the symmetry of europium species in solution and it was concluded that the relative intensities of forced electric dipole and magnetic dipole absorption or fluorescence bands are probably a better indication of the interaction of a europium ion with its surroundings than shifts of specific bands. (auth)

378 SOME CHLORO-COMPLEXES OF QUINQUEVALENT PROTACTINIUM, NIOBIUM, AND TANTALUM. K. W. Bagnall and D. Brown (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Chem. Soc., 3021-5(Sept. 1964).

Hexachloroprotactinates(v) of the type M^IPaCl_6 ($M^I = Cs^+$, Me_4N^+, and Ph_4As^+) and the octachloroprotactinate(v) $(Me_4N)_3PaCl_8$ were prepared from thionyl chloride solutions of protactinium pentachloride. Some analogous hexachlorocomplexes of niobium(v) and tantalum(v) ($M^I = Cs^+$, NH_4^+, and Me_4N^+) were prepared in the same way. The crystallographic and spectral properties of the compounds are discussed. A simple method of preparing the pentachlorides is reported. (auth)

379 CATHODIC ACTION OF THE URANYL–MALATE COMPLEXES AT THE DROPPING MERCURY ELECTRODE. Tsai-teh Lai and Song-jey Wey (Kung Univ., Taiwan, China). J. Electrochem. Soc., 111: 1283-6(Nov. 1964).

The uranyl ion in malic acid solution was investigated by polarography and conductometry. Evidence is presented for the existence of three kinds of chelate species, $UO_2(HA)_2$, $UO_2(A)_2^{-2}$, and $UO_2(OH)A_2^{-3}$. Their structures and electrode reactions at various pH values were established. In the temperature range from 9.1 to 21.5°C the chelates exist as a dimer. On raising the temperature of 28.5°C the depolymerization takes place completely to form a monomer. (auth)

380 TETRAVALENT COMPOUNDS OF PRASEODYMIUM. REPORT III. INVESTIGATION OF PRASEODUMIUM(IV) AND TERBIUM(IV) FLUORIDE COMPLEXES. Sw. Pajakoff (Technische Hochschule, Vienna). Monatsh. Chem., 95: 1002-4(1964). (In German)

By fluorination of praseodymium(III) and terbium(III) fluorides in the presence of alkali fluorides and temperature-stable alkali fluorometalates, yellow alkali fluoropraseodymate(IV) or alkali fluoroterbate originated, which were insensitive to moisture content at higher temperatures. These compounds were stabilized by the alkali fluorometallates with formation of a solid solution. (tr-auth)

381 RARE GAS COMPOUNDS. H. Schwarz (Technische Hochschule, Karlsruhe, Ger.). Naturwissenschaften, 51: 397-403(1964). (In German)

The first unsuccessful studies on the preparation of rare gas compounds are briefly summarized. The preparation of compounds in which the rare gas was held in the sealed cavities of crystals was then considered. The studies made since the middle of 1962 on the preparation of chemical compounds of the rare earths are reviewed. 36 references. (J.S.R.)

382 INVESTIGATIONS ON THE PRODUCTION OF URANIUM TETRAFLUORIDE BY REACTING URANIUM

DIOXIDE WITH ANHYDROUS HYDROGEN FLUORIDE. Rudolf Siebert and Siegfried Ziegenbalg. Neue Hutte, No. 1, 23-9(1964).

383 TEMPERATURE DEPENDENCE OF THE ELECTROLUMINESCENCE OF ZnS–Cu, Al PHOSPHORS. V. V. Nuvareva and P. E. Ramazanov. Opt. Spectry. (USSR) (English Transl.), 17: 42-4(July 1964). Translated from Optika i Spektroskopiya, 17: 86-2(July 1964).

The temperature dependence of the electroluminescence of three ZnS–Cu, Al phosphors excited by fields of various frequencies and strengths, and the thermoluminescence of these phosphors after the same electric excitation at a temperature of –180°C are investigated. It is shown that an additional high-temperature peak may appear on the temperature dependence curve under certain conditions. A hypothetical explanation of the origin of this peak is given. The form of the temperature dependence is connected with the action of different traps. (auth)

384 EMPIRICAL REGULARITY OF CHARGE EXCHANGE. H. Fetz and H. Bussmann (Universität, Würzburg, Ger.). Phys. Letters, 12: 321-2(Oct. 15, 1964). (In German)

For determination of the ionization function of uncharged particles in a gas, an exact knowledge of the charge exchange cross section Q_u is necessary. Cross sections were determined as a function of the velocity of the bombarding ion. (M.C.G.)

385 THEORY OF THE NUCLEAR MAGNETIC RESONANCE CHEMICAL SHIFT OF Xe IN XENON GAS. Frank J. Adrian (Johns Hopkins Univ., Silver Spring, Md.). Phys. Rev., 136: A980-7(Nov. 16, 1964).

A theoretical study is made of the density-proportional paramagnetic shift of the resonant magnetic field observed in nuclear magnetic resonance studies of ^{129}Xe in pure xenon gas by Streever and Carr. The theory is based on a computation of the chemical shift in diatomic molecules formed by colliding Xe atoms, including the effects of van der Waals and exchange interactions on the wave function of the colliding atoms. The results of this calculation show that only the exchange interactions between the colliding atoms make a significant contribution to the chemical shift. When averaged over the various types of collisions, the following value is obtained for the shift in the resonant field: $\Delta H = -2.85(10)^{-7}\ H\rho$, where H is the field strength and ρ is the density in amagats. This is in order-of-magnitude agreement with the observed result: $\Delta H = -4.3(10)^{-7}\ \rho H$. (auth)

386 STABILITY OF CRYSTALS OF RARE-GAS ATOMS AND ALKALI HALIDES IN TERMS OF THREE-BODY INTERACTIONS. II. ALKALI-HALIDE CRYSTALS. Erminio Lombardi and Laurens Jansen (Battelle Memorial Inst., Geneva). Phys. Rev., 136: A1011-23(Nov. 16, 1964).

By extending the theory developed in a previous publication for the stability of rare-gas crystals, it is shown that the stability of alkali-halide crystals can be explained in terms of three-body exchange interactions between the ions. As in the case of rare-gas crystals, the analysis is based on a first- and second-order perturbation calculation with a Gaussian effective-electron model. The different size of anion and cation of each solid is taken into account. The effect on stability of double-exchange contributions to the three-body energy (negligible for rare-gas crystals) is analyzed in detail. It is shown that the theory accounts for all observed regularities on a quantitative basis. In particular, cesium chloride, bromide, and iodide are found to be stable in the cesium chloride modification; furthermore, calculated and observed values for the pressure of transition from the sodium chloride to the cesium chloride configuration are in good agreement. (auth)

387 ISOTOPIC SHIFT IN THE ELECTRON-SPIN-RESONANCE ABSORPTION SPECTRUM OF Cr^{3+} IN MAGNESIUM OXIDE. S. A. Marshall, J. A. Hodges, and R. A. Serway (Illinois Inst. of Tech., Chicago). Phys. Rev., 136: A1024-9(Nov. 16, 1964).

The fine and hyperfine structure spectra of trivalent ^{52}Cr ($I = 0$) and ^{53}Cr ($I = 3/2$) located substitutionally for magnesium in magnesium oxide at sites of axial symmetry, where the axial distortion is along a crystal [100] direction, were re-examined at 3-cm wavelength. Spectral constants for both isotopes were measured with a precision equivalent to determining absorption-line field positions to within ±10 mOe. From measurements taken at 77°K, it is concluded that the crystalline-field splitting energy for ^{52}Cr is (0.10 ± 0.01) Oe greater in magnitude than that for ^{53}Cr, which corresponds to a relative shift in this parameter of 1.1×10^{-4}. In addition, the components of the spectroscopic splitting tensor for the two isotopes are found to be the same to within the limits of experimental error. From data taken over the range 4.2 through 350°K, it is found that the isotopic shift decreases with temperature while the crystalline-field splitting energy increases with temperature. The origin of the isotopic shift and its temperature dependence are discussed in terms of a dynamical crystal structure. (auth)

388 COMPLEX FLUOROXENATES(VI). R. D. Peacock, H. Selig, and I. Sheft (Argonne National Lab., Ill.). Proc. Chem. Soc., 285(Sept. 1964).

The preparation of complexes between xenon hexafluoride and the alkali fluorides is discussed. The preparation and properties of xenon fluoride complexes with cesium and rubidium fluorides are described. Rubidium and cesium octafluoroxenate are the most stable solid xenon compounds yet known. (P.C.H.)

389 RATE AND PRODUCT ISOTOPE EFFECTS IN PROTON-TRANSFER REACTIONS. V. Gold and M. A. Kessick (London Univ.). Proc. Chem. Soc., 295(Sept. 1964).

Differences in the values for kinetic isotope effects measured by direct rate comparison or product comparison are discussed. Special attention is given to the hydration of isobutene in dilute aqueous acid. It is believed that, in first order, the difference between the two isotope effects can be understood in terms of established theory without the postulation of new effects. The comparative unimportance of the secondary solvent isotope effect is pointed out. (P.C.H.)

390 ON THE FLUORESCENCE SPECTRUM OF DICAESIUM URANYL NITRATE AT 77°K. R. M. Dixit (Atomic Energy Establishment, Trombay, India). Proc. Indian Acad. Sci., Sect. A, 60: 90-8(Aug. 1964).

It is shown that the fluorescence spectrum of $Cs_2UO_2(NO_3)_4$ consists mainly of sequences starting off from the resonance band R followed by "C" the bending frequency and each consisting of bands that can be assigned as (A, B, A + C), (2A, A + B, 2A + C), (3A, 2A + B, 3A + C), etc., where A is the symmetric vibration frequency, B the antisymmetric frequency and C the bending frequency of the linear UO_2^{2+} ion in this lattice. In addition several fundamental frequencies of the nitrate ion and the lattice either alone or coupled to the symmetric frequency A and its overtones were observed. The relevant constants for symmetric frequency, antisymmetric frequency, bending frequency, and resonance frequency are given. (auth)

391 THE DYNAMIC JAHN–TELLER EFFECT IN OCTAHEDRALLY CO-ORDINATED d^9 IONS. Mary C. M. O'Brien (Oxford Univ.). Proc. Roy. Soc. (London), Ser. A, 281: 323-39(Sept. 22, 1964).

The electronic-vibrational states of a d^9 ion in an octahedral complex are discussed in terms of an adiabatic model in which the electronic motion follows the nuclear motion exactly. Expressions for the g-values and the hyperfine structure parameters of the ESR spectrum at high and low temperatures are derived. Relaxation processes and other effects due to the complex part of a crystal are discussed. (auth)

392 STUDY OF TERNARY SOLUTIONS BY AN ISOPIESTIC METHOD. [Part] IV. A. N. Kirgintsev and A. V. Luk'yanov. Radiokhimiya, 6: 449-54(1964). (In Russian)

Aqueous solutions of several salts were studied by isopiestic methods, and activity data at 25°C were tabulated separately for lithium nitrate, sodium nitrate, potassium nitrate, ammonium nitrate, rubidium nitrate, and cesium nitrate in solution with uranyl nitrate in water. The de-

pendence of the molarity on the solution composition under isopiestic conditions was characterized by the deviation of the slope of the ternary mixture from ideality. The $UO_2(NO_3)_2-LiNO_3-H_2O$ solution was shown to be ideal. Deviations were 0.013 for the sodium nitrate solution, −0.055 for potassium nitrate, −0.052 for ammonium nitrate, −0.114 for rubidium nitrate, and −0.265 for cesium nitrate. The dependence of the deviation on the composition is shown in a series of graphs. (TTT)

393 HETEROGENEOUS EQUILIBRIUM IN THE TERNARY SYSTEM $UO_2(NO_3)_2-HNO_3-H_2O$. I. ISOTHERMAL SOLUBILITY OF THE $UO_2(NO_3)_2-HNO_3-H_2O$ SYSTEM AT 25, 35, AND 50°C. M. A. Yakimov and V. Ya. Mishin. Radiokhimiya, 6: 454-9(1964). (In Russian)

Isothermal studies were made at 25, 35, and 50°C of the $UO_2(NO_3)_2-HNO_3-H_2O$ system at equilibrium. The data, which are presented in tabulations, show four regions at all temperatures. These correspond to the uranyl nitrate hexahydrate, trihydrate, and dihydrate and to $UO_2(NO_3)_2 \cdot 2HNO_3$. With increasing temperature the eutectic points were displaced in the direction of the binary system $H_2O-UO_2(NO_3)_2$. The results agreed with other published work on saturated solutions but differed from other work on saturated solutions with very low and very high nitric acid concentrations. One of the compounds obtained in this work, $UO_2(NO_3)_2 \cdot 2HNO_3$, is not described in the literature. However, analytical data obtained exclude other hydrates and the anhydrous form of uranyl nitrate, and the mono-, tri-, and higher solvates from consideration. The back-titrated acid depended on the time that had elapsed after solution of the salt for analysis. Control experiments reported earlier showed that equilibrium is established within 4 to 5 hr in all the solutions studied. The HNO_3 and $UO_2(NO_3)_2$ were determined and the water was calculated by difference. (TTT)

394 ROENTGENOMETRIC STUDY OF THE SYSTEM $U_3O_8-U_2O_5$. N. I. Blinova, V. V. Kurbatov, and V. M. Solnstev. Radiokhimiya, 6: 463-6(1964). (In Russian)

The x-ray-diffraction patterns of U_3O_8 and of the product of its reduction with hydrogen at 370°C, which chemical analysis showed to be U_2O_5 were studied. The intensities of the lines obtained were tabulated along with the spacings of the various planes of the crystals of both U_3O_8 and U_2O_5. It is shown that the oxidation of U_2O_5 causes a continuous deformation of the crystal lattice as a function of oxygen content. It is concluded that: in the course of saturating U_2O_5 with oxygen up to U_3O_8, only the structure of U_2O_5 is observed at all intermediate compositions; the range of compositions from U_2O_5 to U_3O_8 is homogeneous; the lattice of U_3O_8 is a deformed lattice of U_2O_5; and that the lattice of U_3O_8 is rhombic. (TTT)

395 THE MEASUREMENT OF THE COEFFICIENTS OF SELF-DIFFUSION OF RADIOACTIVE ISOTOPES IN DILUTE SOLUTIONS. I. E. Starik and A. I. Yurtov. Radiokhimiya, 6: 466-8(1964). (In Russian)

The coefficient of diffusion was determined by measuring the diffusion through an annular slit formed between the walls of a cylindrical glass tube and a short cylinder of glass centered within it. The slit was about 4 to 6 mm in length and 0.2 mm in breadth. As a test of the apparatus, the diffusion coefficients of HCl and HNO_3 were measured in comparison with literature values and good agreement was obtained. The apparatus was then used to measure the diffusion coefficient of 10^{-3}M $CeCl_3$ in 0.1M HCl using ^{144}Ce as a tracer and determining the movement of cerium by counting. Since in this case the density of the solutions in the two compartments of the apparatus was identical, it was possible to measure the diffusion both upward against the force of gravity and downward with that force. The results were identical within experimental error, showing the absence of any influence from gravitational fields. The apparatus described is considered suitable for use with radioactive isotopes for the determination of diffusion coefficients. (TTT)

396 THE STUDY OF THE STATE OF RADIOACTIVE ISOTOPES BY THE METHOD OF DIFFUSION. I. ON THE METHODS OF MEASUREMENT OF COEFFICIENTS OF DIFFUSION OF RADIOACTIVE ISOTOPES IN EXTREMELY DILUTE SOLUTIONS. I. E. Starik, F. L. Ginzburg, and B. N. Raevskii. Radiokhimiya, 6: 468-74(1964). (In Russian)

Methods of measuring the coefficient of self-diffusion of radioactive isotopes were reviewed with particular emphasis on the "open capillary method" of Anderson and Saddington and the method of diffusion through an annular slit. Both methods were applied for the measurement of the diffusion coefficients of Pu(IV) (10^{-5}M) in 1M HNO_3 and 1M HCl and for Ce(III) (10^{-3}M) in 0.1M HCl. From the good agreement of results by the two methods, it was concluded that under the conditions chosen adsorption does not cause a significant error in either method. It was concluded that the open capillary method is suitable for the study of the diffusion of the ionically dispersed state of radioactive isotopes in extremely dilute solutions within definite limits of the concentration of H^+-ions. Results obtained by the open capillary method and the Starik-Yurtov method in an acidic medium (0.1 to 1.0M) agreed well with each other. In this region of acidity, both methods can be successfully used for the study of the velocity of diffusion of radioactive isotopes in extremely dilute solutions. The Starik-Yurtov method was found to be suitable not only for the study of diffusion of the ionically dispersed state of radioactive isotopes, but also for the study of the diffusion of radiocolloids. (TTT)

397 THE STUDY OF THE STATE OF RADIOACTIVE ISOTOPES BY THE METHOD OF DIFFUSION. II. THE COEFFICIENTS OF SELF-DIFFUSION OF Zr IN HYDROCHLORIC ACID SOLUTIONS. I. E. Starik, F. L. Ginzburg, and B. N. Raevskii. Radiokhimiya, 6: 474-9(1964). (In Russian)

The study of diffusion was applied to determining the state of zirconium as a function of the acidity of the solution and of the total concentration of zirconium ion. Both the open capillary method and the Starik-Yurtov method were used, with the former used only in solutions containing 1M or more of acid. From a region of relatively constant diffusion coefficient from 1 to 3M HCl, the diffusion coefficient fell as the acid was reduced below 0.4M, showing transformation to definitely colloidal behavior. On the basis of the measurement of the coefficients of self-diffusion of zirconium at a concentration of 10^{-5} g-ion/l in HCl, it was found possible to state that the radius of the particles of Zr, calculated from the Stokes-Einstein equation, does not change when the concentration of HCl is increased from 0.3 to 9M, and that the mean change of the ions of zirconium in 1M HCl probably does not exceed 1. On decreasing the concentration of acid below 0.3M, a sharp increase in the dimensions of the diffusing particles was observed; this probably was caused by polymerization of the products of hydrolysis of the zirconium. At a pH > 7.5, it was considered probable that the zirconium forms true negatively charged colloids. (TTT)

398 STUDY OF THE STATE OF RADIOACTIVE ISOTOPES. PART III. THE DIFFUSION COEFFICIENTS OF Sr(II), Ce(III), Am(III), Th(IV), Pu(IV) AND Np(V). I. E. Starik, F. L. Ginzburg and B. N. Raevskii. Radiokhimiya, 6: 496-8(1964). (In Russian)

In view of the considerable interest in the self-diffusion coefficients of heavy ions carrying multiple charges, these values were determined in aqueous solutions of Sr, Ce, Am, Th, Pu, and Np at concentrations not exceeding 10^{-5} g-ions/liter. The open capillary method and the Starik-Yurtov method were used for the measurements, which were carried out at 25 ± 0.05°C; the viscosity of the solutions was determined at the same time by means of an Ostwald viscometer. The isotopes ^{89}Sr, ^{144}Ce, and ^{234}Th were used as indicators. The self-diffusion constants $D \times 10^5$ (in cm^2/sec) ranged from 0.789 to 0.558 for Sr(II), 0.619 to 0.445 for Ce(III), 0.610 to 0.631 for Np(V), 0.293 to 0.319 for Th(IV), and 0.158 to 0.434 for Pu(IV), depending on the acid concentration and thus on the pH of the solutions. The diffusion coefficient of Am(III) in 1M HNO_3 was found to be equal to 0.588 ± 0.005, close to that of the corresponding

Ce(III) solution. Values of the diffusion coefficient at 0 acid concentration were derived by extrapolation. These values lie close to that of the diffusion coefficients at infinite dilution. (TTT)

399 THE HEAT OF DISSOLUTION OF URANYL NITRATE DIHYDRATE IN TRIBUTYL PHOSPHATE. Yu. A. Afanas'ev. Radiokhimiya, 6: 499-500(1964). (In Russian)

The value of the heat of dissolution, required for the study of the solvation process, was again determined for the $UO_2(NO_3)_2 \cdot 2H_2O$ + TBP system within a wide concentration range. Heat measurements were carried out by means of a calorimeter at 25°C; the dihydrate, obtained by drying the hexahydrate over P_2O_5, had a composition of $UO_2(NO_3)_2 \cdot 2.04H_2O$. The results obtained agreed well with the data reported by L. I. Katzin et al. (J. Am. Chem. Soc. 74: (5)1191 (1952)). Dilution from 195 to 16.3 caused only a very slight change in the integral heat of dilution. By using the standard heat of formation and other data of the compounds involved, the ΔH_2 value of the process $UO_2(NO_3)_{2\,solid} + 2\ TBP = UO_2(NO_3)_2 \cdot 2TBP_{liquid}$, ΔH_2 was calculated at −24.0 kcal/mole. A similar calculation based on different experimental data yielded a value of −22.6 kcal/mole. The difference is probably due to errors in the standard heats of formation of $UO_2(NO_3)_{2\,aq}$. (TTT)

400 ELECTROLUMINESCENCE. H. K. Henische (Pennsylvania State Univ., University Park). Rept. Progr. Phys., 27: 369-405(1964).

A survey on electroluminescence is presented with particular reference to the work of the last few years on such aspects as spectral characteristics, intraband relaxation, trapping processes, participation of crystal surfaces, contact phenomena, photo-electroluminescence and field enhancement processes. Recent experiments on injection (including tunnel injection) electroluminescence in zinc sulfide and intermetallic compounds are given special emphasis, and their relevance to the traditional problems associated with phosphor materials is considered in some detail. An introductory outline of the closely related junction laser phenomena is also included. 185 references. (auth)

401 PREPARATION OF THORIUM COMPOUNDS WITH D-GLUCONIC AND D-SACCHARIC ACIDS. Gh. Macarovici and L. Czegledi (Inst. of Chemistry, Cluj). Rev. Roumaine Chim., 9: 411-24(June-July 1964). (In French)

The isolation of solid state compounds of Th with D-gluconic and D-saccharic acids was studied as a function of the pH of the solutions and some of the conditions of synthesis. Five chelato-basic monomer combinations were obtained between Th and D-gluconic or D-saccharic acid. Their reaction mechanism and their structure were investigated, and their structural formulas were indicated. Six other combinations that are present as polymers although their structure could not be defined unequivocally were also synthesized. (tr-auth)

402 CHEMICAL REACTIONS IN CROSSED MOLECULAR BEAMS. J. W. Smith (Univ. of London). Sci. Progr. (London), 52: 601-7(Oct. 1964).

The possibility of directly observing the results of reactions between individual molecules of known kinetic energies is a prospect in chemical kinetics. It has been achieved to some extent by the crossed molecular beam technique, which is discussed. So far the method has been applied to only a few types of chemical reactions, but it seems to be amenable to further extensions as techniques for the detection of the product molecules, radicals, or atoms are developed. Already it has led to a better insight into the significance of such quantities as the activation energies of reactions, and it has shown that the so-called collision diameters for molecular scattering and for chemical reaction may have vastly different values. Results obtained by this method are therefore likely to have far-reaching importance in elucidating the actual mechanisms of chemical reactions. (auth)

403 TRANSITIONS PROBABILITY IN MOLECULAR ENCOUNTERS. PART 6. VIBRATIONAL RELAXATION IN NH_3, ND_3, PH_3 AND PD_3. T. L. Cottrell and A. J. Matheson (Univ. of Edinburgh). Trans. Faraday Soc., 59: 824-9 (Apr. 1963).

On the basis of earlier studies showing that the vibrational relaxation times of tetradeuteriomethane and tetradeuteriosilane are longer than those of methane and silane respectively, which was attributed to vibrational-rotational energy transfer, measurements were made to compare trideuterioammonia and trideuteriophosphine with ammonia and phosphine. The relaxation times were obtained from ultrasonic velocity dispersion measurements in the range 0.08 to Mc sec^{-1} at^{-1} in an acoustic interferometer. The overall relaxation times, τ, in ND_3, PH_3 and PD_3 were 0.13, 1.96, and 3.43×10^{-7} sec, respectively. No dispersion was detected up to 5 Mc sec^{-1} atm^{-1} in NH_3. The results for NH_3 and ND_3 were interpreted in terms of the effect of inversion on the force-time relation during an encounter, and the fact that PD_3 had a longer relaxation time than PH_3 was attributed to vibrational-rotational energy transfer. This very short relaxation time for NH_3 ($<0.015 \times 10^{-7}$ sec^{-1}) was a striking exception to the general rule that compounds with a high ν_{min} (lowest vibration frequency) have long relaxation times. As in the tetrahedral hydrides, the relaxation time for the deuterated phosphine compound was about 1.5 times that for the hydrogen compound. The value of ν_{min} for PH_3 was over 250 cm^{-1} greater than the value of ν_{min} for PD_3, and the molecular velocities and intermolecular forces were similar, so that a simple vibrational-translational energy transfer calculation indicated that the relaxation time for PH_3 should be greater. However, although the translational velocities of PH_3 and PD_3 did not differ greatly, the average peripheral velocity of rotation in PH_3 was about $\sqrt{2}$ times that in PD_3. Increased rotational velocity in PH_3 compared with PD_3 was sufficient to counterbalance the higher vibrational frequency in the former, which explains their relative relaxation times. (BBB)

404 TRANSITION PROBABILITIES IN MOLECULAR ENCOUNTERS. PART 7. FURTHER EVIDENCE FOR VIBRATION-ROTATION ENERGY TRANSFER RELAXATION IN AsH_3 AND AsD_3. T. L. Cottrell, R. C. Dobbie, J. McLain, and A. W. Read (Univ. of Edinburgh). Trans. Faraday Soc., 60: 241-7(Feb. 1964).

As shown previously, the vibrational relaxation times of the hydrides of carbon, silicon, nitrogen, and phosphorus are shorter than those of the corresponding deuterides, in spite of the lower vibration frequencies of the latter. To account for this, it was suggested that vibrational energy is degraded to rotational energy in collisions, and that this is favored in molecules with low moments of inertia. This explanation was supported by a rough calculation, but further tests of the suggestion that vibrational-rotational energy transfer takes place in hydrides and deuterides are undertaken. A calculation was made of the interaction between a classical rotator and a quantum-mechanical vibrator, to see whether this model would predict the observed effect. This calculation showed that vibrational-rotational energy transfer can account for the observed relative vibrational relaxation times in the hydrides and deuterides of elements in groups 4 and 5. Further simple theoretical considerations showed that the ratio of the relaxation time of AsH_3 to that of PH_3 should be of the order unity for vibrational-rotational transitions, and 10^{-2} for vibrational-translational transitions. Vibrational relaxation in AsH_3 and AsD_3 was therefore studied by the ultrasonic method. The relaxation times τ were 0.31 and 0.22 μsec respectively, close to those for PH_3 and PD_3. Thus, further evidence supported the view that vibrational energy is preferentially degraded to rotation in encounters involving molecules with low moments of inertia. This concept theory may only hold for molecules in which the lowest vibration frequency corresponds to a bending motion, so that completely general conclusions about substitution of H by D atoms cannot necessarily be made. (BBB)

405 SPECTROPHOTOMETRIC STUDY OF CITRATE COMPLEX OF RARE-EARTH ELEMENTS IN ALKALINE SOLUTION. V. T. Mishchenko and N. S. Poluektov (Inst. of General and Inorganic Chemistry, Academy of Sciences, Ukrainian SSR). Ukr. Khim. Zh., 30: 663-7(1964). (In Russian)

Spectrophotometric studies of Nd and Er citrate complexes with constant ratios of Met : Cit of 1 : 2 and constant concentrations of reacting ions revealed two types of complexes at pH 4 to 6 and 8 to 10. The molar ratio and isomolar series show that at pH 9 complexes with molecular ratio of Me : Cit of 1 : 1 are formed. (R.V.J.)

406 DIAGRAM OF THE FUSIBILITY OF THE SYSTEM NaCl–KCl–K_2ZrF_6–$NaZrF_6$. I. N. Sheiko, V. I. Melnikov, and V. I. Suprunchuk (Inst. of General and Inorganic Chemistry, Academy of Sciences, Ukrainian SSR). Ukr. Khim. Zh., 30: 688-93(1964). (In Russian)

The preparation and fusion diagram of NaCl–KCl–K_2ZrF_6–Na_2ZrF_6 were studied. Congruently melting K_2ZrF_6Cl and incongruently melting Na_3ZrF_6Cl were found. The first compound exhibited better stability and occupied a larger area in the diagram. Solid solutions of NaCl–KCl were observed only in systems with more than 95% potassium and sodium chlorides. (R.V.J.)

407 THE RESEARCH OF THE OXIDIZING POTENTIAL IN THE SYSTEM CERIC–CEROUS–NITRIC ACID–WATER–TRIBUTYLPHOSPHATE. I. M. Batyaev and M. S. Zakharevskii. Vestn. Leningr. Univ., No. 10, Ser. Fiz. i Khim., No. 2, 84-9(1964). (In Russian)

The oxidizing potential of cerium in the solvent HNO_3 (1m)–H_2O–TBP was measured with N_{H_2O}/N_{TBP} = $1/1.11$ and $1/1.81$. Its values proved to be equal to 1.37 and 1.35 v respectively. (auth)

408 KINETICS OF THE REACTION OF URANO-URANIC OXIDE WITH CARBON MONOXIDE. V. G. Vlasov and V. N. Shalaginov. Zh. Prikl. Khim., 37: 1865-71(Sept. 1964). (In Russian)

The kinetics of Cl_3O_8 reduction by carbon monoxide at 20 to 200 mm Hg were studied at 250 to 450°C (I) and 280 to 450°C (II). The reduction rate of (I) with a specific surface of 2.5 m^2/g, is 2 to 4 times that of (II) with a specific surface 1.1 m^2/g. The maximum rate appeared at 300°, but slowly dropped to zero with the separation of oxygen from the oxide. The activation energy for (I) was 28.6 ± 0.9 kcal/mol and for (II) 18.9 ± 0.9 kcal/mol. It is shown that the surface reaction between adsorbed carbon monoxide and oxygen is the process determinant. (R.V.J.)

409 THORIUM AND BERYLLIUM SILICATES $ThBe_2SiO_5$ AND ISOMORPHOUS RELATIONS WITH FELDSPAR MINERALS. R. G. Grebenshchikov. Zh. Prikl. Khim., 37: 2044-5(Sept. 1964). (In Russian)

Descriptions are given of the preparation, structure, and density of $ThBe_2Si_2O$. It is shown that beryllium and thorium silicates melt congruently at 1700°C. Specimens containing 80 wt % $BaAl_2Si_2O_8$ and 20 wt % $ThBe_2Si_2O_8$ annealed at 1400 to 1450°C showed a higher mechanical strength than pure barium feldspar. (R.V.J.)

410 KOMPLEKSNYE SOEDINENIYA URANA. (Complex Uranium Compounds). I. I. Chernyaev, ed. Moscow, Publishing House "Sciences," 1964. 490p.

Complexing properties of uranium are analyzed, and data are given on the properties and structures of hexa- and tetravalent uranium compounds. A geometric analysis was made of various uranyl compounds, and electron structure and complexing reactions in basic technological processes are described. Methods for completing various uranium compounds are included. (R.V.J.)

411 THE STRUCTURE OF LIQUIDS AND SOLUTIONS AS IT APPLIES TO EXCITATION ENERGY AND CHARGE MIGRATION PROCESSES. John S. Avery and Ronald Mason (Imperial Coll. of Science and Tech., London). p.197-214 of "Physical Processes in Radiation Biology." New York, Academic Press, 1964.

Periodicity certainly contributes to the high mobility of electrons and holes, a fact which makes speculations about the role of structured solutions particularly interesting. But a number of features of migration phenomena are independent of periodicity and may form the framework for transport processes in systems lacking in long-range order. Delocalized wave functions are appropriate in the case of strong coupling ($|H'_{m,n}| > h\Gamma$) for both periodic and amorphous aggregates, and many features of the electron band structure of crystals are preserved on melting. (auth)

412 TWO-STEPPED METHOD OF PRODUCING BERYLLIUM. Leslie Jack Derham (to National Smelting Co. Ltd.). German Patent 1,168,087. Apr. 16, 1964. Priority date May 5, 1959, Great Britain.

Ammonium beryllium fluoride is mixed with chips of magnesium, the mixture briquetted, the briquettes heated in vacuo to a temperature of 400°C, and the ammonium fluorides removed. The beryllium fluoride–magnesium briquettes are molten at a temperature of 1350°C. (Gmelin Inst.)

413 A METHOD FOR THE ENRICHMENT OF DEUTERIUM IN AMMONIA BY CATALYTICALLY PROMOTED ISOTOPE EXCHANGE BETWEEN LIQUID AMMONIA AND A SYNTHETIC GAS FLOWING IN THE OPPOSITE DIRECTION. Bertrand Lazard (to Commissariat à l'Energia Atomique). German Patent 1,168,395. Apr. 23, 1964. Priority date Dec. 14, 1960, France.

The ammonia, deuterium-enriched and containing the catalyst, after leaving the exchange columns through which it was guided, is fed to one or two evaporator stages from which the ammonia evaporated from the mixture is returned to one column and a concentrated catalyst solution produced in the evaporator stage or stages is returned to the heads of the exchange columns after the catalyst solution is led against an ammonia synthetic gas, which was branched off the gas stream at the end of the exchange columns. The synthetic gas particles that were in contact with the catalyst solution in the contact columns are fed into locations of the exchange columns corresponding to their deuterium content. The catalyst solution removed from the exchange columns is evaporated to dryness in the evaporator stage or stages. A concentrated catalyst solution is prepared from the dry catalyst by means of part of the ammonia to be fed to one of the exchange columns or by means of the ammonia produced in one evaporation stage. This catalyst solution, after being in contact with the synthesis gas in the contact column or columns, is added to the liquid ammonia flow at suitable positions. (Gmelin Inst.)

414 A METHOD FOR THE PRODUCTION OF MILLIMETER-SIZED THORIUM OXIDE OR THORIUM/URANIUM OXIDE PARTICLES. Kenneth Hall McCorkle, Alfred Todd Kleinsteuber, Charles Edmund Schilling, and Orlen Camp Dean (to U. S. Atomic Energy Commission). German Patent 1,168,400. Apr. 23, 1964. Priority date Nov. 25, 1960, United States.

The respective oxide sols were evaporated in order to produce gels, and subsequently calcinated. By drying the nitrate-containing oxide sol at temperatures of 50 to 100°C, the oxide gel was produced containing nitrate and water in equivalent proportions of, altogether, 3.5 to 7 wt %. The dried gel was slowly heated to at least 450°C, at a rate not exceeding 100°C per hour, and the heated solids were rapidly calcinated at a temperature of at least 1,150°C. (Gmelin Inst.)

Organic Chemistry

Refer also to abstracts 32 and 182.

415 (NAA-SR-5128) VAPOR PRESSURE OF POLYPHENYL COOLANTS. H. Mandel, F. Silvey, and K. Koda (Atomics International. Div. of North American, Inc., Canoga Park, Calif.). Oct. 15, 1964. Contract AT-11-1-GEN-8. 24p. Dep.; $2.00(cy), 1(mn) OTS.

The vapor pressures of pure diphenyl, o-, m-, and p-terphenyl, triphenylene, two mixtures of the terphenyl isomers known as Santowax-R and Santowax-OMP, and four terphenyl binary mixtures were determined using a constant volume cell in the temperature range of 450 to 900°F. The method employed consisted of matching the pressure exerted by a test sample at constant temperature with a known external pressure. Latent heats of vaporization of

Santowax-OMP and of its major components were calculated using the experimental data. (auth)

416 (NYO-2669-1) X-RAY STRUCTURE STUDIES OF SUBSTITUTED ALUMINUM ALKYLS. Annual Report, September 15, 1963–September 15, 1964. E. L. Amma (Pittsburgh. Univ.). Sept. 1964. Contract AT(30-1)-2669. 18p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The refinement of trimethylaluminum crystal structure was completed during the period. Work directed toward determining the crystal structure of methylaluminum dichloride is discussed along with work on structural data concerning aluminum isopropoxide. (J.R.D.)

417 (ORNL-3679(p.49-59)) ORGANIC CHEMISTRY. (Oak Ridge National Lab., Tenn.).

No isotope effect was observed in the reaction between o-tolualdehyde, labeled in the methyl group with ^{14}C, and 2,4-dinitrophenylhydrazine. The chemical shifts of the hydroxylic protons, recorded in the nuclear magnetic resonance spectra of several pairs of diastereoisomeric 1,2-glycols, were correlated with the configurations of the compounds. Carbon-14 labeling was used to study the mechanism of the thermal decarboxylation of the Fe salts of fatty acids and of mixed fatty acids and Fe benzoate. The data are consistent with a mechanism that involves a six-membered cyclic intermediate. The reaction affords a convenient route for the synthesis of labeled alkyl phenyl ketones. Irradiation, with unfiltered ultraviolet light, of aroyl cyanides was found to produce benzils. The study was extended to determine the generality of the reaction. Aroyl chlorides were shown to inhibit benzil formation and to promote the formation of an unstable addition compound, which may be an intermediate in the formation of benzil during the normal irradiation procedure. 3-endo-Amino-2-endo-phenylnorborneol and 3-endo-amino-2-exo-phenylnorborneol were prepared and subjected to deaminating conditions. Several products are formed from both reactants, and five of these from the latter aminoalcohol were isolated and purified. One compound, 3-cyclohexenyl phenyl ketone, was identified as a reaction product from the deamination of both aminoalcohols studied. The 2,4-dinitrobenzenesulfenate esters of erythro- and threo-3-phenyl-2-butanol-1-^{14}C were subjected to chlorinolysis both in acetic acid and in chloroform solutions. Optically active as well as racemic samples were studied. The products were identified, and in certain cases the distributions of the ^{14}C labels were determined. Whenever possible the degree of optical purity of each product was observed. From these data mechanisms for the chlorinolyses were established, which include ion-pair intermediates. The rearrangement of 2-phenylnorbornane-2,3-cis-exo-diol (VI) in concentrated H_2SO_4 at 0°C was found to take place with intramolecular migration of H from C-3 to C-2. Rearrangement of the norbornane C skeleton also occurs, with an accompanying 6,1-shift of H. The configuration of the product, 3-endo-phenyl-2-norbornanone(VII), is inverted with respect to the configuration of reactant (VI). The results, attained with tritium, ^{14}C, and stereochemical studies, can best be accommodated by assuming nonclassical carbonium ion intermediates. A series of amides was prepared and tested for the solvent extraction of U and Th. Dramatic differences in the selectivity of U over Th were detected in those N,N-dialkyl amides that contained three groups on the alpha C atom. The distribution coefficients for U varied inversely with the size of the alkyl groups on the N atom. Dibutyl dimethylphosphoramidate was hydrolyzed with scission of the P–N bond in heterogeneous systems when a solution was passed over a cation exchange resin in the H form or when a hexane solution of the amidate was equilibrated with aqueous HCl. The hexane solution of the amidate was not hydrolyzed when equilibrated with distilled water. Triallyl phosphate, an ester of an unsaturated alcohol, when tested as the stationary liquid phase for the separation of alkanes and alkenes, was found to perform like triethyl phosphate which gave better resolution of butene-1, cis- and trans-butene-2, and 1,3-butadiene than did tributyl phosphate. (auth)

418 THE DEUTERIUM ISOTOPE EFFECT IN THE RACEMIZATION OF 2,2′-DIBROMO-4,4′-DICARBOXYBIPHENYL. Lars Melander and Robert E. Carter (Nobel Inst. of Chemistry, Stockholm). Acta Chem. Scand., 18: 1138-49(1964).

2,2′-Dibromo-4,4′-dicarboxybiphenyl-6,6′-d_2 was synthesized and its rate of racemization compared to that of the protium compound within the temperature interval −20 to 0°C. The rate ratio k_D/k_H was found to be about 1.18, corresponding to a $\Delta\Delta F^{\neq}$ value of about 90 cal/mole. The accuracy has not allowed a separation of the latter magnitude into its enthalpy and entropy components. A computation that assumes the effect to be entirely due to an internal-energy difference, gives a value of $\Delta\Delta E^{\neq}$ in good agreement with the experimental $\Delta\Delta F^{\neq}$ when a recently proposed hydrogen-bromine non-bonded repulsion potential is used. The prediction is very sensitive, however, to the choice of potential function, and the agreement might be fortuitous. (auth)

419 ON THE ACCELERATION OF CLEAVAGE OF OLIGOSACCHARIDES IN THE PRESENCE OF METAL IONS. H. Trapmann and S. Sethi (Universität, Munich). Arch. Pharm., 295: 925-7(1962). (In German)

A series of metal ions Th, Zr, Ce, La) have been shown to be suitable for disruption of the glucosidic bonds of oligosaccharides at ordinary temperatures. The hydrolysis of disaccharides is accelerated in both acid and alkaline media in the presence of certain metal ions, but for trisaccharides this occurred only in acid media. The glucosidic bonds of the disaccharides, lactose, sucrose, turanose, cellibiose, and melibiose are disrupted when Th and Zr ions are present. At a pH of 3.5 and a temperature of 37° the catalytic effects of the metal ions is small, but at a higher reaction temperature (70°) the reaction proceeds rapidly. Sucrose, turanose, and melibiose are hydrolyzed best by Th, but Zr is more effective with lactose and cellibiose. Under the reaction conditions used, La and Ce(III) ions show no catalytic effect. Trehalose glucosidic bonds are unaffected even after treatment at 70° for 120 hr. In the alkaline range (pH 8.8) La ions have a very great effect, Th and Ce(III) ions a moderate effect, and Zr ions the least catalytic effect. The catalytic effect decreases in the order, La : Th : Ce(III) : Zr, for turanose, lactose, cellibiose, and melibiose. Sucrose and trehalose are unreactive after alkaline treatment at 70° for 120 hr. When Th and Zr ions were used at pH 3.5, the trisaccharides raffinose and melezitose were split up. The dissolution of the first glucosidic bond was very rapid, and was detectable chromatographically within 30 to 60 min after the reaction was initiated. Raffinose is first split into d-fructose and melibiose, and reaction of the resulting disaccharide intermediate is complete within 24 hr. Melezitose is split into d-glucose and turanose. The catalytic effects of Zr and Th ions are the same for both sugars. At pH 8.8 both trisaccharides are resistant to the treatment. None of the ions, Th, Zr, La, or Ce(III), was able to break the glucosidic bonds, even at 70°. (BBB)

420 ORGANIC SYNTHESES WITH HEAVY ISOTOPES. PART I. SOME DEUTERIUM-SUBSTITUTED NORMAL LONG-CHAIN SATURATED HYDROCARBONS, ACIDS, AND ESTERS. Dinh-Nguyen Nguyen (Universität, Goteborg). Arkiv Kemi, 22: 151-67(1964).

Metal-catalyzed deuteriations of olefinic or halogen-substituted methyl esters cannot be used for the deuteriation of compounds at specific sites owing to a considerable nonspecific exchange that occurs in these reactions. Such exchange also occurs during desulfurization by means of Raney nickel. An attempt was made to synthesize methyl 9,9-dideuteriooctadecanoate by desulfurization of the ethylene mercaptal prepared from methyl 9-oxooctadecanoate and ethane-dithiol. The reaction was carried out by means of deuterized Raney nickel in boiling dioxan. The product was a saturated ester, which was a mixture of methyl octadecanoates of different D content. A comparison of their spectrum with those of catalytically deuteriated methyl 12-chlorooctadecanoate, methyl 9,10-dibromooctadecanoate, and methyl cis-octadecen-9-oate (methyl oleate)

showed that the final distribution in some of these D-substituted methyl octadecanoates prepared by different methods are similar in spite of the use of different catalysts and different reaction conditions. In the esterification of 2,2-dideuterioheptadecanoic acid-d by means of diazomethane, exchange reaction also led to a series of methyl esters containing zero to three D atoms in the ester methoxyl group as well as two D atoms localized in the carbon chain. Platinum- and sodium deuterioxide-catalyzed H-D exchange at 200° was successfully utilized to introduce two D atoms in the α-position in the case of Na octadecanoate. Nonmetal-catalyzed H-D exchange was used in the synthesis of 2,2-dideuterio-substituted acids via 2-decyl-2-deuteriomalonic acid-d_2 and 2-pentadecyl-2-deuteriomalonic acid-d_2. Anodic condensation (Kolbe reaction) was successfully applied to synthesize long-chain hydrocarbons and methyl esters D-labeled at specific sites. (BBB)

421 ORGANIC COMPLEXES OF URANIUM. PART I. THE SYNTHESIS AND SPECTRUM OF URANYL PHTHALOCYANINE. J. E. Bloor, J. Schlabitz, C. C. Walden, and A. Demerdache (British Columbia Research Council, Vancouver). Can. J. Chem., 42: 2201-8(Oct. 1964).

The preparation of uranyl phthalocyanine from uranyl chloride and dilithium phthalocyanine is described. The infrared and electronic spectra of the complex are quite different from that previously reported for uranyl phthalocyanine, and it is suggested that previous workers obtained mainly a mixture of phthalocyanine (PcH_2) and inorganic uranyl compounds. The infrared spectra of α- and β-PcH_2, β-PcCu, $PcLi_2$, and $PcUO_2$ from 4000 to 300 cm^{-1}; the far infrared spectra of β-PcH_2, β-PcCu, and $PcUO_2$ from 300 to 100 cm^{-1}; and the electronic spectrum from 3500 to 10,000 Å of $PcUO_2$ in 1-chloronaphthalene are recorded. A tentative assignment of a band at 278 cm^{-1} to the O–U–O bending frequency is made. The electronic spectrum of $PcUO_2$ differs from previous spectra of metal phthalocyanines in that it possesses no strong absorption in the 6000–7000 Å region. It does, however, have a strong band at 9145 Å, $\epsilon = 4.15 \times 10^4$. (auth)

422 ISOTOPIC EXCHANGE AS A CRITERION OF STRUCTURE OF COMPLEXES. II. ISOTOPIC EXCHANGE IN $[Re_2O(OH)_6(C_2O_4)_2]^{4-}$–$^{14}C_2O_4^{2-}$ AND $[Re_2O(OH)_2(C_2O_4)_4]^{4-}$–$^{14}C_2O_4^{2-}$ SYSTEMS. Stanislaw Wajda (Univ. of Wroclaw, Poland). Nukleonika, 9: 815-28(1964). (In Polish)

In the system $[Re_2O(OH)_6(C_2O_4)_2]^{4-}$–$^{14}C_2O_4^{2-}$ the exchange proceeds slowly with a great activation energy and the reaction is of –1 order. In the $[Re_2O(OH)_2(C_2O_4)_4]^{4-}$–$^{14}C_2O_4^{2-}$ system the oxalate ions do not exchange with the oxalato groups in the complex. It permitted to deline the spatial configuration of both complexes, which explains their simultaneous arising during the coordination and the impossibility of their passing one into another. (auth)

423 MÖSSBAUER RESONANCE STUDIES IN IRON PORPHYRIN AND HEME PROTEIN. J. E. Maling and M. Weissbluth (Stanford Univ., Calif.). p.93-104 of "Electronic Aspects of Biochemistry." New York, Academic Press, 1964.

The ^{57}Fe Mössbauer resonance is observed at room temperature in iron porphyrins and heme proteins containing the natural Fe isotopic distribution. Inferences that can be drawn from the Mössbauer spectra, as to the environment of the Fe nucleus in the molecule, are discussed. (T.F.H.)

Radiation Chemistry

Refer also to abstracts 174 and 1003.

424 (HW-81746(p.3.103-5)) EVIDENCE FOR THE REACTION OF ATOMIC CHLORINE RADICALS IN NEUTRAL IRRADIATED SOLUTIONS. D. R. Kalkwarf (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

The presence of chloride ion during irradiation of several neutral aqueous solutions altered the course of the reactions induced. This alteration could not be attributed to a change in ionic strength of the solutions and was considered to be an indication of the chlorine atoms. (auth)

425 (HW-81746(p.3.105-7)) THE EFFECT OF TEMPERATURE ON RADICAL-CAPTURING REACTIONS IN IRRADIATED AQUEOUS SOLUTIONS. D. R. Kalkwarf (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). (HW-SA-3064)

A variety of ionic and neutral solutes were found to compete more effectively with erioglaucine for the hydroxyl radicals formed in irradiated aqueous solutions as the temperature was decreased. Viewed in terms of differences in activation energies for competing reactions, these differences fell within a 3.5 kcal $mole^{-1}$ range. (auth)

426 (HW-81746(p.3.107-10)) POSTIRRADIATION EFFECTS IN AQUEOUS DYE SOLUTIONS. W. D. Felix and D. R. Kalkwarf (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Evaluation of the reaction-rate constants of tropeolin-O and erioglaucine with hydrogen peroxide showed that these reactions are too slow to account for the postirradiation bleaching of these dyes in aqueous solutions. This postirradiation effect is thus attributed to the reaction of relatively long-lived organic radicals in the solution. (auth)

427 (HW-81746(p.3.113-19)) KINETIC STUDIES OF ORGANIC RADICALS FORMED IN IRRADIATED AQUEOUS SOLUTION. R. N. Diebel and D. R. Kalkwarf (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Organic free radicals, formed by gamma irradiation of aqueous solutions, were studied in a continuous flow system, which was monitored by an electron spin resonance spectrometer. Radicals formed from p-nitroaniline were found to have half lives of 15 sec even at room temperature. (auth)

428 (ORNL-3676(p.81-111)) INSULATING CRYSTALS. (Oak Ridge National Lab., Tenn.).

COLOR-CENTER PRODUCTION AT LIQUID-NITROGEN TEMPERATURE. A study of F-center and V_k-center production by ionizing radiation in KCl is in progress. Results show that lead impurity causes the rate of production and the limiting V_k-center concentration to be increased. Lead also increases the F colorability. Heating of lead-doped samples prior to irradiation also affects the V_k- and F-center production. However, the way in which these changes in coloring properties take place is not yet clear. K-BAND IN KCl AT LOW TEMPERATURES. The shape of the K-band in KCl was examined in detail at low temperatures. There is no evidence of a doublet structure, and the K-band is distinctly non-Gaussian. EFFECT OF LEAD ON THE ROOM-TEMPERATURE COLORABILITY OF KCl. Abstract of paper submitted for journal publication. F-CENTER PRODUCTION AT ROOM TEMPERATURE. After long irradiation the F-center concentration in KCl at room temperature no longer continues to grow. A study of this limiting value has shown that it is a function of temperature and radiation intensity. Moreover, limited results suggest that the rate of approach to steady state is also dependent upon temperature. A MODEL FOR RADIATION EQUILIBRIUM BETWEEN F- AND M-CENTERS IN KCl. Previously published paper. RADIATION-INDUCED OPTICAL ABSORPTION NEAR THE ABSORPTION EDGE OF KCl. Examination of radiation-produced ultraviolet absorption spectra between 190 mμ and the visible has indicated that some of the disagreement in the literature concerning bands in that range may be due to two factors. There appears to be a number of broad, unresolved bands whose number and rate of appearance seem to depend upon the particular sample used; some of these bands may be peaking at a wavelength shorter than 190 mμ, the limit of some spectrophotometers. Preliminary measurements between 190 mμ and the absorption edge were made with a nitrogen-purged spectrophotometer. EFFECT OF PLASTIC DEFORMATION ON THE PRODUCTION OF F-, M-, AND V-CENTERS IN KCl. Abstract of published paper. EFFECT OF IMPURITIES ON THE HARDENING AND COLORATION OF KCl IRRADIATED AT ROOM TEMPERA-

TURE. It is shown that the early-stage coloration process does not contribute appreciably to radiation hardening in KCl, whereas the late-stage coloration mechanism produces hardening centers. Also, the total number of F-centers produced in early-stage coloration is only a small percentage of the total amount of impurity present in the crystal. This suggests that only unassociated positive-ion vacancies can participate in impurity-induced early-stage coloration. LUMINESCENCE OF GAMMA-IRRADIATED KCl UNDER PLASTIC DEFORMATION. Initial studies were made of the triboluminescence of gamma-irradiated KCl. The spectrum of this deformation luminescence is similar to that observed by Timusk and Martienssen when they irradiated uncolored KCl with 10.3-ev light. However, the data show that the simple mechanism offered by these workers to explain the emission they observed cannot be the only one operative during plastic deformation of gamma-colored KCl. NEAR-ULTRAVIOLET LUMINESCENCE IN POTASSIUM IODIDE. The luminescence characteristic of "pure" KI at 370 mμ is found to be associated with the self-trapped hole. Experiments indicate that this emission results from recombination of an electron with the self-trapped hole. LIGHT SCATTERING IN ALKALI HALIDE SINGLE CRYSTALS. Abstract of published paper. (auth)

429 (ORNL-3679(p.39-48)) RADIATION CHEMISTRY. (Oak Ridge National Lab., Tenn.).

A series of reactions to explain the role of CO_2 as a sensitizing agent in the radiation-induced synthesis of water was postulated. The same scheme (omitting the reactions involving CO_2) is applicable to the nonsensitized reaction. Rate equations were derived from these mechanisms, and rate constants were calculated. The constants for both reactions are 7.3 $curie^{-1}$. CO_2 appears to enter into the mechanism even though no CO_2 is consumed in the overall reaction. An induction period in CH_4 radiolysis due to the presence of O_2 in the CH_4 is described. Yields (G values) for O_2 consumption were measured and C_2H_4 production was observed. After the induction dose, or in its absence, $G(C_2H_6) = 2.36 \pm 0.12$ and $G(C_3H_8) = 0.54 \pm 0.03$ molecule/100 ev. The role of C_2H_4 in CH_4 radiolysis was studied by irradiation of CH_4 containing added O_2, C_2H_4, or C_2H_2. With added O_2, the C_2H_4 yield in CH_4 radiolysis was $G(C_2H_4) = 0.83 \pm 0.01$ molecule/100 ev. With added C_2H_2, about 40% of the C_2H_2 consumption leads to C_2H_4 formation and the much higher C_2H_4 yields are not indicative of the C_2H_4 yield from CH_4 itself. The radiolysis of condensed CH_4 at 77 and 90°K was studied. Yields of C_2H_6, H_2, C_3H_8, and C_4H_{10} were much less than in gas-phase radiolysis. CH_4 containing added C_2H_4 or C_2H_2 was irradiated to determine G values for their consumption at 90°K and their effect on product yields. From the polymer yield determined by others, the G value for CH_4 disappearance at 77°K is estimated to be only 5.4 molecules/100 ev compared with gas-phase values of 8 to 9 at room temperature. In the radiolysis of water, experimental evidence was obtained for reaction, in the spur, of solute with electronically excited water molecules. A new diffusion model is proposed. The effect of formic acid on the photochemical reduction of ceric ion yielded further evidence for the OH radical as an intermediate and for reaction of OH radical with sulfuric acid. Study of the radiolysis of aqueous H_2SO_4 solutions consisted of three parts: (1) the determination of the reasons why ceric ion solutions purged with He during irradiation give lower cerous ion yields than solutions simply saturated with He, (2) the development of an analytical procedure for the analysis of micromolar concentrations of cerous ions, and (3) some aspects of the Ce–Tl system. The effects of LET (linear energy transfer), or track effects, on the radiolysis of several solids were studied. Yields were compared for irradiation by gamma rays and alpha particles in the production of ClO^-, ClO_2^-, and ClO_3^- from sodium chlorate and of NO_2^- from ammonium nitrate and in the production of color in polystyrene and polymethylmethacrylate. The annealing behavior was also studied. The radiolytic decomposition of anhydrous calcium and barium bromates by ^{60}Co gamma rays was investigated. The bromate decomposition in the Ca salt increased nonlinearly with radiation dose up to ca. 7×10^{22} ev/mole. Br oxidation states intermediate between bromate and bromide were produced; the yield of these also was nonlinear with increasing dose. The production of bromide ion showed that following an initial increase, the rate of formation appeared to become and remain approximately constant. Initial 100-ev radiolytic yields were estimated to be: $G_0(-BrO_3^-) = 2.24$, $G_0(Br^-) = 0.44$, and $G_0(\text{"Ox"}) = 1.80$. The average oxidation number of the oxidizing fragments decreased from an initial value of 3.5 to a constant value of 2.05 after approximately 0.5 mole % decomposition. The extent of the radiolysis of BrO_3^- ion in $Ba(BrO_3)_2$ was observed to increase with the temperature at which the salt was dried in a vacuum prior to irradiation. This effect is thought to be due to a phase transition as indicated by DTA studies. The initial G value for the decomposition of BrO_3^- ion by ^6Li fission recoil particles was found to be 1.48, and the corresponding value for oxidizing fragment production (BrO_2^- + BrO^-) 1.1 molecules/100 ev. These values are five times larger than those of ^{60}Co gamma rays indicating a large LET effect, but no change in the radiolytic mechanism. The yields remained unchanged for a tenfold increase in the dose rate. Irradiations in the Bulk Shielding Reactor of molten lithium nitrate containing 1.0 at. % ^6Li for periods varying up to 2 hr showed that: (1) nitrite and O_2 are the primary decomposition products and these are produced in a stoichiometric ratio of approximately 2 to 1; (2) the initial G values for the production of nitrite and O_2 are 5.4 and 2.3, respectively, or about 25 times greater than for solid-state irradiations at 40°C; (3) the decomposition vs dose curves are nonlinear and give lower G values at higher doses; and (4) greater than 99.9% of the gaseous decomposition products are released from the molten salt. A maximum fission dose of 7×10^{22} ev/mole was absorbed in the 2-hr irradiation period. (auth)

430 (ORNL-P-591) "EXPLOSION" OF MULTICHARGED MOLECULAR IONS: CHEMICAL CONSEQUENCES OF INNER SHELL VACANCIES. Thomas A. Carlson and R. Milford White (Oak Ridge National Lab., Tenn.). [1964]. Contract W-7405-eng-26. 16p. (CONF-773-1). Dep.(mn); $1.00(cy), 1(mn) OTS.

For Presentation at Symposium on Chemical Effects Associated with Nuclear Reactions and Radioactive Transformation, Vienna, Dec. 1964.

Molecules containing atoms that undergo internal conversion or electron capture are subject to extensive decomposition. This decomposition results from the large number of electrons that an atom loses as it adjusts to a vacancy in one of its inner shells. Electrons are pulled from the rest of the molecule to the region of high positive charge, and the whole molecule literally "explodes" from coulombic repulsion. A short review is first made of the past work on the molecular consequences to inner shell vacancies with particular emphasis on gases examined with a charge spectrometer. This previous work, however, has been limited to qualitative observations. A description is then given of a new charge spectrometer, which utilizes x rays to initiate inner shell vacancies. With this spectrometer it is possible to measure the relative abundances of all the fragment ions formed in the decomposition of the parent molecule without the errors that arose earlier from a dependence of collection efficiency on recoil energy. Furthermore, it was possible to measure the recoil spectrum for each of the ions. As an example, some recently acquired data are given on the decomposition of CH_3I following vacancies formed primarily in the L shell of iodine by x rays. The decomposition is violent, with the molecule decomposing almost entirely into H^+, C^{n+}, and I^{n+}. The relative abundance of molecular ions is very small. The sums of the carbon, iodine, and hydrogen ions are in the approximate ratios of 1 : 1 : 3 suggesting that the quantity of neutral species is also small. The most abundant carbon ion is C^{2+}, which possesses an average recoil energy of about 40 ev. The most abundant iodine species is I^{5+}, which contrasts with an average charge of eight from an analysis of Xe ions produced with x-rays of the same energy. These and other data on the recoil and charge spectra from CH_3I are compared with the calculations using a model of a multiple-ion coulomb "explosion." (auth)

431 (TID-21121) CHEMICAL EFFECTS OF THE NUCLEAR REACTION $N^{14}(n,p)C^{14}$ IN VARIOUS IRRADIATED NITROGENEOUS COMPOUNDS. Final Report. RECOIL CHEMISTRY OF CARBON-14 IN THERMAL-NEUTRON-IRRADIATED HYDRAZINE DIHYDROCHLORIDE. Supplement to Final Report. John D. Vaughan (Virginia Polytechnic Inst., Blacksburg). [1964]. Contract AT(40-1)-2726. 38p. Drp.(mn); $2.00(cy), 1(mn) OTS.

Previous investigations of the distribution of ^{14}C in various irradiated targets after dissolution, are reviewed. An experimental study was made of the recoil chemistry of carbon in liquid hydrazine and in hydrazinium salts, and results are tabulated for the sulfate and dihydrochloride salts of hydrazine. The development of chemical and physical models to account for the distribution of recoil carbon is described for the sulfate salt. Research was continued in aqueous and liquid hydrazine solutions of irradiated hydrazine dihydrochloride, and results are compared with those for the sulfate. (D.L.C.)

432 (TID-21236) GAMMA-RADIATION-INDUCED DECOMPOSITION OF ALKALI NITRATE CRYSTALS (thesis). Raymond G. Di Martini (Stevens Inst. of Tech., Hoboken, N. J.). [nd]. Contract AT(30-1)-1824. 129p. Dep.(mn); $4.00(cy), 3(mn) OTS.

Gamma radiolysis of alkali nitrates has been studied using a variety of physico-chemical techniques, including x-ray diffraction, infrared spectrophotometry, ultraviolet spectrophotometry and optical microscopy. The basic reaction which takes place is decomposition of nitrate ion to nitrite ion with oxygen molecules formed and trapped in the lattice. Data gathered indicate, that for a given material, decomposition products are not just a function of dose. Single crystal material and powder material were used to show that factors such as impurity content, crystal perfection, crystal size, crystal surface treatment, and crystal geometry are effective in producing variations in the amount of nitrate decomposition obtained at a given dose. Controlled impurity content experiments were extensively investigated for the substance KNO_3. Radiation produces defect sites which are effective in trapping electrons in s type or p type orbitals. Charge compensation and extension partially limit the number of traps that can be formed. An injection of vacancies into the crystal leads to a dislocation density decrease, which in turn, results in nucleation and interface movement controlling topochemical decomposition. (auth)

433 (TID-21250) THE ATMOSPHERIC PRESSURE GAS-PHASE RADIOLYSIS BY COBALT-60 GAMMA RAYS OF ACETYLENE, ETHYLENE AND VINYL CHLORIDE (thesis). Harry Jenkins Suggs (Vanderbilt Univ., Nashville). May 1964. Contract [AT(40-1)-1087]. 92p. (AD-441024). Dep.(mn); $3.00(cy), 2(mn) OTS.

Gamma radiolysis of ethylene at atm pressure required 20 days to attain 12% conversion. Over 30% of the reacted ethylene went to acetylene and H. The G value for the disappearance of ethylene was found to be 75, nearly twice that found in x-ray radiolysis. The G value for the gamma radiolysis of acetylene was 81.9. However, the effect of the acetone impurity on the acetylene radiolysis is unknown. (auth)

434 (UCRL-11387(Suppl.)(p.1-7)) ON THE SPATIAL DISTRIBUTION OF RADICALS PRODUCED BY IRRADIATION. S. J. Wyard (California. Univ., Berkeley. Lawrence Radiation Lab.).

Preliminary results are reported from studies on the spatial distribution of radicals produced by ultraviolet or ionizing radiations in frozen solutions of hydrogen peroxide. Electron spin resonance techniques were used in the measurements. Data are presented on the buildup of radical concentration with radiation dose. (C H.)

435 (UCRL-11387(Suppl.)(p.8-13)) EPR STUDIES ON OH RADICAL IDENTIFICATION IN IRRADIATED H_2O. T. E. Gunter and C. D. Jeffries (California. Univ., Berkeley. Lawrence Radiation Lab.).

Results are reported from electron spin resonance studies of the OH radical in irradiated water in the form of water of crystallization in $CaSO_4 \cdot 2H_2O$. It is pointed out that in this crystal the water occupies only two inequivalent sites and the proton density is much less than in ice itself. The spectra of irradiated $CaSO_4 \cdot 2H_2O$ observed at 77°K showed an anisotropic hyperfine doublet with two inequivalent sites and a weak isotropic line near the free-electron g factor. Results are compared with electron spin resonance studies on single crystals of ice irradiated at 77°K and studied at both 77°K and 4.2°K. (C.H.)

436 (USNRDL-TR-769) MASS YIELDS IN THE FAST NEUTRON FISSION OF U^{233}. L. R. Bunney and E. M. Scadden (Naval Radiological Defense Lab., San Francisco). July 31, 1964. Contract AT(49-2)-116. 12p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The cumulative yields of sixteen mass chains in the fission of ^{233}U by fission-spectrum neutrons were determined by radiochemical methods. The mass chains were mostly in the rare earth region of the yield curve. In general, the last radioactive member of the mass chain was isolated and its activity measured relative to the activity of ^{99}Mo. With this ratio, with pertinent data from the thermal neutron fission of ^{235}U, and with the absolute yield of mass 99 in the fission-spectrum neutron fission of ^{233}U, the chain yield was calculated. The accuracy of the determinations is estimated to be ±15%, except for mass 161 where it is estimated to be ±30%. The mass-yield curve for the fission-spectrum neutron fission of ^{233}U was outlined by reflecting the yield values with the assumption that the average number of neutrons emitted per fission was 2.5. The mass yields in the fission-spectrum neutron fission of ^{233}U differed from the mass yields in the thermal neutron fission of ^{233}U in a manner analagous to the behavior of these same mass yields in the fission-spectrum and thermal-neutron fission of ^{235}U. (auth)

437 (JPRS-26808(p.132-9)) THE INFLUENCE OF GAMMA-RADIATION ON THE ELECTRICAL CONDUCTIVITY OF WATER. N. N. Aborina and V. Ya. Kozlov. Translated from p.156-65 of "10 Let Pervoy v Mire Atomnoy Elektrostantsii SSR."

The degree of influence of gamma radiation on the electric conductivity of water was investigated, and it was found that within the limits of the accuracy of measurements that gamma radiation has no effect on the electric conductivity of water. (C.E.S.)

438 RADIATION-INDUCED POLYMERIZATION IN THE SOLID STATE. I. POSTPOLYMERIZATION OF N-VINYLCARBAZOLE. J. Kroh and W. Pekala (Technical Univ., Lodz, Poland). Bull. Acad. Polon. Sci., Ser. Sci. Chim., 12: 419-23(1964).

Studies were made on the radioinduced polymerization of solid N-vinylcarbazole (NVC) with special attention to the significance of the crystalline form of the monomer for the mechanism of post-polymerization. The polymer yield obtained during the irradiation was very low and independent of the presence of air or of the crystalline form of the monomer. In all cases the percentage of conversion was within the range 0.59-0.67%. At 20°C post-polymerization still occurred after 300 hr, however, after 250 hr the process slowed down markedly. At 40°C the induction period (at 20°C about 100 hr) was much shorter and saturation was reached after about 50 hr. The saturated samples were quite stable, even after 350 hr of storage at constant temperature. The temperature of the samples was raised from 40 to 60°C for a period of 24 hr to investigate the latent reactivity of the saturated system. This was done after 74 and 100 hr post-polymerization. In both cases a further increase by about 10% in the degree of conversion was observed. (P.C.H.)

439 DETERMINATION OF THE RATIO OF VELOCITY CONSTANTS OF NITROUS OXIDE AND NITRATE IONS WITH SOLVATE ELECTRONS PRODUCED BY γ RADIOLYSIS OF NEUTRAL AQUEOUS SOLUTIONS. Anne-Marie Koulkes-Pujo and Harvey A. Mahlman (Université, Paris). Compt. Rend., 259: 788-90(July 27, 1964). (In French)

The ratio of the velocity constants of N_2O and nitrate ions with solvated electrons, determined by the measurement of the yield of N_2 formed by radiolysis of mixtures of these

two compounds in aqueous solution, seems to establish that potassium nitrate is a captor of electrons 2.7 times better than N_2O. The electron yield determined in these conditions is 2.58. (tr-auth)

440 THE NATURE OF THE FREE RADICALS INDUCED BY X IRRADIATION OF DEOXYRIBONUCLEIC ACID IN THE SOLID STATE. Albert Van de Vorst and Freddy Villée (Université, Liège). Compt. Rend., 259: 928-31(July 27, 1964). (In French)

The paramagnetic resonance spectrum of DNA fibers irradiated with x rays was studied. The results obtained suggested a localization of the radicals induced in the pair of guanine-cytosine bases. (tr-auth)

441 CHEMICAL NUCLEAR REACTORS. Helmut Krauch, W. Baur, K. Jecht, and W. Kunz. Dechema Monograph., 42: 145-96. (In German)

Four radiochemical syntheses were experimentally investigated for possible industrial production in chemical nuclear reactors. The conditions for the synthesis of nitrogen dioxide, hydrazine, phenol from benzene, and glycol from methanol are described. The design and operation of heterogeneous and homogeneous chemical nuclear reactors are discussed. Energy absorption in the reaction mixture for chemical reactions induced by γ and neutron irradiation is considered. The flow diagram for phenol synthesis is given, and decontamination and finishing of the reaction products are described. A product cost analysis for chemical nuclear reactors is included. (J.S.R.)

442 A NUMBER OF PROBLEMS IN THE RADIATION POLYMERIZATION AND COPOLYMERIZATION OF TETRAFLUOROETHYLENE (TFE) IN THE SOLID STATE. M. A. Bruk, A. D. Abkin, P. M. Khomikovskii, G. A. Gol'der, and Hsiang-ling Chu. Dokl. Akad. Nauk SSSR, 157: 1399-1402(Aug. 21, 1964). (In Russian)

On irradiating TFE with γ-rays or fast electrons, an increase in particle reactivity was observed at −165°C. The solid monomer irradiated at a lower temperature begins to polymerize at a temperature of 10° below the melting point. An x-ray analysis did not indicate any structural changes at −196 and −155°C. In order to elucidate the mechanism of the process (radical or ionic), the copolymerization of tetrafluoroethylene (TFE) and trifluorochloroethylene (TFCE) was investigated in the gaseous (+62°C), liquid (0°C), and solid (−170°C) phases with γ irradiation. The copolymerization of the monomers in gaseous and liquid phases took place according to a radical mechanism, as shown by the fact that the composition of the copolymers at various monomer ratios was equal to the composition of the initial mixture (the copolymerization rate constants were equal to one). With the solid state copolymerization, on the other hand, the copolymers were enriched in the TFE component in all cases. The rate constants for the copolymerization were $r_1 = 25$ for TFE, and $r_2 = 0.04$ for TFCE. These facts indicate that the radiation copolymerization of TFE and TFCE in the solid state takes place by a different mechanism, probably an ionic mechanism. In all probability radiation polymerization of TFE in the solid state also takes place according to this same mechanism. (TTT)

443 THE SYNTHESIS OF COMPLEX SEMICONDUCTING MATERIALS BY RADIATION GRAFT POLYMERIZATION IN THE GAS PHASE. A. V. Vlasov (Kazakh State Univ., SSR), P. Ya. Glazunov, Yu. L. Morozov, I. I. Patalakh, L. S. Polak, S. R. Rafikov, and B. L. Tsetlin. Dokl. Akad. Nauk SSSR, 158: 141-2(Sept. 1, 1964). (In Russian)

In order to obtain an organic, semiconducting polymer with high mechanical strength, a glass backing thread consisting of 1000 strands having a thickness of 6−7 μ was irradiated with electrons at 150°C in the presence of phenylacetylene vapor (400 mm Hg std) at a dose of 2×10^5 Rads. The irradiated glass fiber fixed about 14 wt % of a graft polymer of phenylacetylene. The electric conductivity of the graft polymer thread increased sharply on increasing the temperature, and at a temperature of 300°C, the specific electric conductivity was 1.3×10^{-5} ohm^{-1} cm^{-1}. On irradiating a glass thread at a temperature of 80°C in the presence of acrylonitrile vapors (200 mm Hg std), it was found that 12 wt % of a polymer had been grafted onto the glass thread. The graft polymer thread was heated to 500°C in an atmosphere of nitrogen in order to impart semiconducting properties to the graft polymer. The specific electric conductivity of the graft polymer increased with increasing temperature. The mechanical strength of the graft polymeric fiber was 40−50 kg/mm^2. Other polymeric materials and backings are being investigated. (TTT)

444 A NEW METHOD OF ESTIMATING THE RATIO OF RATE CONSTANTS IN REACTIONS INVOLVING A RADICAL AND AN ACCEPTOR. L. T. Bugaenko (Moscow State Univ.). Dokl. Akad. Nauk SSSR, 158: 186-8(Sept. 1, 1964). (In Russian)

The yields of the molecular radiolysis products of water (H_2 or H_2O_2) G_m as a function of the concentration of acceptor radicals C_A has the following form in many cases: $G_m = G_m^0 - q\,C_A^{\frac{1}{2}}$. Here q is a parameter depending on the type of acceptor, the kind of radiation, the radical, and the molecular product. Let q_1 and q_2 be the values of the empirical coefficients for the acceptor radicals A_1 and A_2. Then, it can be shown that the ratio of the reaction rate constants has the following form: $k(A_1)/k(A_2) = (q_1/q_2)^3$. This relationship holds, if the type of radiation, the temperature, and pH of the solutions are the same. The ratio of the reaction rate constants were calculated for a number of acceptors of the solvated electron and of the H atom and of the OH radical in neutral and acid solution, and were compared with the ratios of rate constants obtained by the method of competing acceptors. Both methods give values that are the same in order of magnitude. The ratio of rate constants were found to be ~1.8 for the reaction of H atoms with the acceptors Ce^{4+} and H_2O_2 in 0.4M H_2SO_4, 7 for the reaction of OH radicals with the acceptors Br^- and Cl^- in 0.4M H_2SO_4, and 1.0 for the reaction of e^-_{aq} with the acceptors acrylamide and Cu^{2+} in neutral solution. If it is assumed that the value of $k(e^-_{aq} + Cu^{+}) = 3.0 \times 10^{10}$ mol/l · sec for a neutral solution, that the value of $k(H + H_2O_2) = 4 \times 10^7$ mol/l · sec for an acid solution, and that the value of $k(OH + Ce^{3+}) = 3.2 \times 10^8$ mol/l · sec in neutral and acid solutions, the absolute values of the reaction rate constants of e^-_{aq}, H, and OH with other ions can be calculated. These values are tabulated and compared with the literature values. (TTT)

445 PROTON MAGNETIC RESONANCE IN GAMMA-IRRADIATED POLYISOBUTYLENE. N. M. Sergeev and V. L. Karpov. Fiz. Tverd. Tela, 6: 2179-80(1964).

Measurements were made with a spectrometer (25 Mc/sec) using a nonfractionated polyisobutylene (PIB) sample at room temperature, with exposure in air from a ^{60}Co unit (~100 Rad/sec). A decrease in the NMR line width with increasing radiation dose turned out to be smaller than expected. A possible explanation is that in spite of the successive destruction of the PIB under the influence of the radiation, the chains still remain intertwined, and the character of segmental motion (microviscosity) remains little changed. Simultaneous high-resolution measurements of the spectra of PIB solutions in CCl_4 showed that in highly diluted solutions (~10 mg/cm^3) the NMR line width does not depend strongly on the irradiation, indicating that the line width is not connected directly with the characteristic viscosity, which changes by several orders of magnitude as a result of irradiation. (OTS)

446 CERIC DOSIMETER. Ho-ming Chen. Hua Hseuh Tung Pao, No. 8, 44-7(1964). (In Chinese)

Ceric dosimeters are better than the usually employed ferrosulfate type instruments because they have a wider range of measurement and may reach the level of $5 \cdot 10^4$ R. Operation is based on the reduction of the Ce^{4+} ion in aqueous solution after irradiation. The presence of O in the system does not affect the reduction process. The optical dispersion method in the uv region was found to be an excellent method for the determination of the Ce^{4+} ions before and after the irradiation; the difference of these numbers indicates the number of Ce^{3+} created. This determination

is best carried out in $2 \cdot 10^{-4}$ M ceric salt solutions. The results are affected by the presence of organic impurities in the solution; a small amount of organic impurity increases the rate of reduction. The size of the container should be large enough to ensure complete transfer of energy of the secondary ions to the system. It should be recalled that the Ce^{4+} solutions are light-sensitive. The amount of Ce^{3+} ions increases with decreasing temperature. The dosimeters yield results with an accuracy ranging from 2 to 5%, if used properly. (TTT)

447 FLUORESCENCE OF GaAs UNDER INTENSE ELECTRON EXCITATION. R. V. Babcock (Westinghouse Research Labs., Pittsburgh). J. Appl. Phys., 35: 3354-7 (Nov. 1964).

Fluorescent emission from Te- or Zn-doped GaAs was examined under electron beam excitation sufficient to generate electron-hole pairs at rates ranging from 3×10^{22} to 4×10^{25} cm^{-3} sec^{-1} and over the temperature range from 77 to 300°K. Peak emission frequencies were constant in this intensity range, and the spectrum from Zn-doped samples agreed qualitatively with transitions between acceptor states and a Boltzmann population in the conduction band. Te-doped samples showed strong emission at 1.494 ev. An unsuccessful attempt was made to excite coherent emission with excitation intensities exceeding 8×10^{25} cm^{-3} sec^{-1}. No spectrum narrowing or shift in emission frequency was observed; this is consistent with a recombination lifetime of 6×10^{-10} sec or less. (auth)

448 INFLUENCE OF TEMPERATURE ON THE ELECTRIC REINFORCEMENT EFFECT OF α SCINTILLATIONS IN MANGANESE-ACTIVATED ZINC SULFIDE. R. Henck and A. Coche (Centre de Recherches Nucleaires, Strasbourg). J. Phys. (Paris), 25: 731-6(July 1964). (In French)

The variation of the enhancement of α-ray excited luminescence by electric fields, in manganese-activated zinc–cadmium sulfides, has been studied between –175 and +60°C, for each of the two emission bands (blue and orange). The results distinguish two different mechanisms, accounting for enhancement and quenching effects. At low temperatures, the electric field releases trapped electrons. Different trap levels have been determined by thermoluminescence. At high temperatures, the enhancement of the orange emission band is attributed to energy transfer by holes from blue centers to manganese centers. (auth)

449 ELECTRON RADIATION OF AQUEOUS METHYL CELLULOSE SOLUTIONS. W. Jack Hillend and Harold A. Swenson (Inst. of Paper Chemistry, Appleton, Wis.). J. Polymer Sci., Pt. A, 2: 4921-30(Nov. 1964).

Solutions (4%) of commercial methyl cellulose (85,000 weight-average molecular weight) were radiated with electrons under varied atmospheres of oxygen at dose rates of 0.15, 0.45, and 4.5 MRad/min to total doses of 0.45, 4.5, and 10.0 MRad. Sampler irradiated at the highest dose rates formed gels whose strength was estimated in a Brookfield viscometer. After dispersing by stirring, the gels were clarified by centrifugation before viscosity, light-scattering, and sedimentation measurements were made. Molecular weight increases to as high as 270,000 were found, and the sedimentation coefficients increased correspondingly. The intrinsic viscosity of the irradiated polymer solutions, on the other hand, did not increase as the molecular weight doubled or tripled. This is interpreted to be the result of recoupling of hydrolyzed fragments to produce branched molecules of smaller volume and greater weight. High dose rates promoted molecular weight increases while the presence of oxygen, low dose rates, and low polymer concentration favored degradation. The carboxyls evidently produced in the oxidative degradation resulted in a lowered pH of the irradiated solution and in polyelectrolyte viscosity behavior. Boiling an irradiated polymer solution at pH 10.5 reduced molecular weight from 270,000 to 165,000, showing the presence of alkali-labile as well as alkali-stable bonds. The gels on the other hand could be dispersed by stirring or heat as well as by alkali. Although branching may affect gelation to some extent, the molecular weight and sedimentation of the samples in solution appear to be approaching a maximum at the dosage level where the more labile bonding of the gelation phenomenon sets in. (auth)

450 DIFFUSION OF OXYGEN IN GAMMA-IRRADIATED POLYETHYLENE. R. C. Giberson (General Electric Co., Richland, Wash.). J. Polymer Sci., Pt. A, 2: 4965-71(Nov. 1964). (HW-SA-2379)

Theories of gas flow in polymers developed by Michaels and others were used to calculate the diffusion coefficient for oxygen in γ irradiated polyethylene. The value obtained is in good agreement with that obtained from an independent method. The possible effect of dose rate on Michaels' theories is presented. (auth)

451 A COMPARISON OF THE CROSSLINKING OF HIGHLY ORIENTED AND NON-ORIENTED CRYSTALLINE POLYETHYLENE BY IONIZING RADIATION. R. Kitamaru and L. Mandelkern (Florida State Univ., Tallahassee). J. Polymer Sci., Pt. B, 2: 1019-23(Nov. 1964).

A comparison study was made on the crosslinking efficiency between the highly axially oriented crystalline state and the non-oriented but crystalline state of irradiated polyethylene. It was found that at room temperature crosslinking is more effective in the undeformed crystalline specimen. Gel formation in the highly oriented sample was significantly retarded and even at the extremely high dosages used 65% of the sample remained sol. The fraction gel produced depended on the temperature of the sample at the time of irradiation. Wide angle x-ray diffraction patterns indicated that the high state of axial orientation is maintained in the fibrous specimen even after heating at 120°C for 4 hr. The results also demonstrate the decreased crosslinking efficiency of the oriented specimen at low temperatures. However, for irradiation temperatures between 70 and 100°C the situation changed and the fraction gel produced became essentially the same for the two cases. Above 100°C the formation of slightly more gel was observed in the oriented specimen. (P.C.H.)

452 RADIATION POLYMERIZATION OF TRITHIANE TO POLYTHIOMETHYLENE: STRUCTURE AND ORIENTATION OF POLYMER CRYSTALS. Gianalvise Carazzolo (Centro Ricerche Resine Soc. Montecatini, Castellanza, Italy) and Mario Mammi. J. Polymer Sci., Pt. B, 2: 1057-9(Nov. 1964).

Data on the structure and orientation of polymer crystals in the radioinduced polymerization of trithiane to polythiomethylene are reported. It is inferred that the polymer a axis and the trithiane c axis are parallel; thus the solid state polymerization takes place in a direction (or directions) perpendicular to the Z axis of trithiane, in a way quite different from that previously described for the solid state polymerization of trioxane to hexagonal polyoxymethylene. It is hypothesized that if the a, b, and c axes of trithiane are coincident with the direction d_0 1_0, c and a axes of the hexagonal lattice of the polymer, respectively, there is a minimum volume distortion in the course of polymerization. It was concluded that the solid state polymerization of trithiane takes place probably along its b axis. (P.C.H.)

453 THE EFFECTS OF γ-RAYS ON POLYMERS IN AQUEOUS SOLUTION. I. γ-RAY IRRADIATION OF AN AQUEOUS SOLUTION OF POLYVINYL ALCOHOL IN PRESENCE OF OXYGEN. Akira Matsumoto (Tokyo Metropolitan Univ.). Kobunshi Kagaku, 20: 268-74(1963). (In Japanese)

The effects of ^{60}Co irradiation at a rate of 8×10^4 r/hr on aqueous solutions of polyvinyl alcohol (PVA) in presence of oxygen were studied. Random degradation of PVA was observed under a high-oxygen atmosphere, but when the oxygen dissolved in solution was lower, crosslinking occurred. Thus, oxygen tension plays a very important role in the radiation effects on the aqueous PVA solutions. G values for main chain scission were found to be 0.2 to 0.6, which became larger at higher dose rate and higher concentration. When H_2O_2 was added at the concentration of 10^{-2} mol/l, G_d values became four times as large as the previous values. Main-chain scission occurred predominantly at 1,2-diol linkage and partially at other linkages. G values for the production of carbonyl groups in PVA were

about two. When the samples were kept at 100°C for a few minutes after irradiation, the G value was reduced to one. Since the increase in number of carbonyl groups produced by γ irradiation was larger than that of main chain scission, it was concluded that the produced carbonyl groups are of the ketone type in main chains. (BBB)

454 INVESTIGATION OF THE PRODUCTION OF ION EXCHANGE MEMBRANES BY RADIATION-INDUCED GRAFT COPOLYMERIZATION WITH THE ELECTRON BEAM OF A VAN DE GRAAFF GENERATOR. L. Wuckel, T. Czvikovszky, H.-J. Heinrich, H. Langner, and E. Sprokenbach (Institut fur Angewandte Physik, Dresden). Monatsber. Deut. Akad. Wiss. Berlin, 6: 484-6(1964). (In German)

The radioinduced graft copolymerization of styrol on polyethylene by the method of pre-irradiation with electrons was investigated for use in the preparation of ion exchange membranes. Polyethylene films were irradiated in the electron beam of a Van de Graaff generator and then heated in freshly distilled styrol or treated with styrol vapor. (M.C.G.)

455 THE ALPHA AND GAMMA RADIOLYSIS OF BIPHENYL. W. H. Baldwin and P. S. Rudolph (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng., 20: 548-50(Dec. 1964).

The yields of gases, cycloalkanes, and benzene-soluble and benzene-insoluble polymers from alpha- and gamma-radiolysis of biphenyl are measured. The yields of these products from the reactions of biphenyl with di-t-butyl peroxide, a free-radical initiator, are compared with the yields from radiolysis. (T.F.H.)

456 POLARIZATION ABILITY OF CATIONS AND FORMATION OF HYDROGEN PEROXIDE IN AERATED AQUEOUS SOLUTIONS OF SULPHATES EXPOSED TO Co-60 γ-RADIATION. I. TEMPERATURE DEPENDENCE OF PROCESS FOR 0.50 M SOLUTIONS OF Li^+, Na^+, K^+, Rb^+ AND Cs^+. Stefan Minc and Eugeniusz Weźranowski (Inst. of Nuclear Research, Warsaw). Nukleonika, 9: 795-800(1964).

The influence of the hydration energy of cations in aqueous 0.50 M solution of Li, Na, K, Rb, and Cs sulphates on the yield of hydrogen peroxide $G(H_2O_2)$ was investigated. The observed relations between temperature of the solution and $G(H_2O_2)$ indicate the diffusional character of the passage of radicals from the r spur into the solution. The higher the temperature of solution the higher the rate of diffusion of radicals from the spur and the higher the $G(H_2O_2)$ up to the equilibrium, reached at 60–80°C. It was found that the yields of hydrogen peroxide depend on the cation present, and are the higher the lower is the hydration energy of the cation. (auth)

457 AN INVESTIGATION OF THE Ni^+ ION IN IRRADIATED LiF AND NaF. W. Hayes and J. Wilkens (Oxford Univ.). Proc. Roy. Soc. (London), Ser. A, 281: 340-65 (Sept. 22, 1964).

The effects of ionizing radiations on LiF:Ni and NaF:Ni crystals were investigated by paramagnetic resonance methods. Nickel dissolves substitutionally in LiF and NaF in the divalent state and is associated with charge compensating positive ion vacancies or vacancy aggregates. When the crystals are exposed to ionizing radiations at room temperature, the $Ni^{2+}(3d^8,{}^3F)$ ions trap electrons forming $Ni^+(3d^9,{}^2D)$ ions which are, in general, associated with a variety of vacancy configurations. Eight different Ni^+ complexes were investigated in both LiF and NaF, and detailed models are proposed for some of these. The annealing behavior of the Ni^+ complexes in the room-temperature and low-temperature irradiated crystals is described. The symmetry of the Ni^+ complexes is less than cubic because of the Jahn-Teller effect and associated vacancies, and both $|x^2-y^2\rangle$ and $|3z^2-r^2\rangle$ ground states are observed. The ground state of unassociated Ni^+ ions is $|3z^2-r^2\rangle$. The fluorine hyperfine structure of the Ni^+ spectra was investigated. Effects are observed in both the g values and the fluorine structure, which are attributed to zero point vibrational admixtures of the $|x^2-y^2\rangle$ and $|3z^2-r^2\rangle$ states. The effects of the nickel impurity on F- and M-band formation in the crystals are described. (auth)

458 ENHANCED IONIC POLYMERIZATION OF STYRENE INDUCED BY RADIATION. A. Charlesby and J. Morris (Royal Military Coll. of Science, Swindon, Eng.). Proc. Roy. Soc. (London), Ser. A, 281: 392-400(Sept. 22, 1964).

The yield of polymer formed by low-temperature irradiation of styrene in methylene dichloride was measured at various concentrations of monomer and at different intensities. Corresponding yields were also determined when polymerization occurred in the presence of Aerosil (fine silica powder). Analysis of the results by means of a Mayo type of plot shows that the increased yield with Aerosil is due to a reduction in the termination step. Chain transfer during propagation is found to explain the relatively small difference in measured molecular weights. Over much of the range studied, the intensity exponent is about 1 without and 0.5 with Aerosil. The former agrees with the usual kinetics involving a termination by the original gegenion, while the latter requires termination by a species produced in a separate ionizing event. (auth)

459 THE CHEMICAL ACTION OF THE RECOILS OF ^{38}Cl ATOMS IN CHLOROMETHANES. THE PECULIARITIES OF THE YIELDS OF THE REACTION $^{37}Cl(n,\gamma)^{38}Cl$ BY COMPARISON WITH $^{81}Br(n,\gamma)^{82}Br$. L. Vasharosh (Vásáros), E. S. Filatov, and An. N. Nesmeyanov. Radiokhimiya, 6: 484-90(1964). (In Russian)

Chemical effects of the recoil of ^{38}Cl formed by the reaction $^{37}Cl(n,\gamma)^{38}Cl$ were studied by irradiating various chloromethanes in neutron fluxes, using Po–Be and Sb–Be sources and a low neutron flux from a reactor. The effects of the addition of varying amounts of iodine as an acceptor were compared with those of Br_2 and Cl_2 with regard to its influence on the fraction of the activated chlorine retained in the organic molecule. It was shown that the chemical behavior of the recoil atoms of ^{38}Cl formed by the reaction $^{37}Cl(n,\gamma)^{38}Cl$ in the chloromethanes CH_2Cl_2, $CHCl_3$, and CCl_4, does not differ from that of ^{82}Br. The total retention and the yields of parent compounds were determined as a function of the addition of an acceptor for radicals (I_2). On the basis of the data obtained with ^{38}Cl and data for ^{82}Br, a mechanism and the energy range for the reaction of recoil atoms of ^{38}Cl and ^{82}Br are discussed. (TTT)

460 IRRADIATED BENZO-[A]-PYRENE. III. IRRADIATION IN THE PRESENCE OF OXYGEN. G. Milazzo, C. G. Casinovi, and Maria A. Ciasca (Istituto Superiore di Sanita, Rome). Rend. Ist. Super. Sanita, 23: 1065-72(1960). (In Italian)

A solution of benzopyrene in n-hexane irradiated with ^{60}Co gave three products, two of which were identified as benzo-[a]-pyren-1,6-quinone and benzo-[a]-pyren-3,6-quinone. A possible explanation is suggested. (auth)

461 RESEARCH ON RADIOLYSIS OF NEUTRAL AND ALKALINE SOLUTIONS OF SODIUM AND AMMONIUM SULFATES IN THE PRESENCE OF OXYGEN AND AIR. A. Călugaru (Inst. of Atomic Physics, Bucharest). Rev. Roumaine Phys., 9: 455-69(1964). (In French)

The effect of irradiation on neutral and alkaline solutions of Na_2SO_4 and $(NH_4)_2SO_4$, saturated with oxygen or air, was investigated. The concentration of the oxygen and the hydrogen peroxide was determined by the polarographic method. In solutions of $(NH_4)_2SO_4$ and NH_4OH it was established that the radiolysis process depends on the surface state of the gold used as an irradiation source (^{198}Au). It was found that the radiolytic elimination of oxygen from the neutral solution of $(NH_4)_2SO_4$ is relatively rapid up to a concentration of 0.163 mmol O_2/l (absorbed dose of 3×10^{21} ev/l) when the formation of H_2O_2 begins. In the same solutions with an excess of NH_4OH, the decrease of oxygen continues up to 0.09 mmol/l (absorbed dose of 4×10^{21} ev/l), also when the formation of H_2O_2 begins. In solutions of Na_2SO_4, initially saturated with O_2, there is a complete radiolytic elimination of the O_2 after the absorption of a dose of 130×10^{21} ev/l. (tr-auth)

462 RADIATION-INDUCED GRAFT POLYMERS OF COTTON CELLULOSE AND STYRENE. Jett C. Arthur, Jr., and Donald J. Daigle (Dept. of Agriculture, New Orleans). Textile Res. J., 34: 653-4(July 1964).

The formation and some molecular relations of radioin-

duced graft polymers of cotton cellulose and styrene were investigated. Mixtures were irradiated at about 25°C by gamma radiation from ^{60}Co to dosages ranging from 1 to 50×10^{19} ev/g of cellulose. On irradiation, the graft polymerization of styrene monomer onto cellulose was initiated, terminating at a degree of polymerization (DP) of 3000 to 5000 for polystyrene. The DP of the cellulose decreased with increasing dosage. The amount of polystyrene grafted onto the cellulose increased with increasing dosage. On degradation of the cellulose, polystyrene was isolated in yields of 60 to 90% of the total grafted polystyrene. The average molecular weights of the polystyrene ranged from about 600,000 at low dosages to about 300,000 at high dosages. The radiochemical yields of molecules of grafted polystyrene ranged from a G value of 1.5 at low dosages to a G value of 0.6 at high dosages. The ratio of cellulose (taking into consideration chain breaks) to molecules of grafted polystyrene in the graft polymers ranged from about 11 to 7 with increasing dosage. Data on molecular relations are tabulated. (P.C.H.)

463 DECAY BEHAVIOR OF LIQUID ORGANIC SCINTILLATORS. Werner Stolz (Technische Universität, Dresden). Wiss. Z. Techn. Univ. Dresden, 12: 1167-71 (1963). (In German)

Conclusions on the special type of energy transfer processes from the solvent to the scintillation components were derived from measurements on the external decay time of liquid organic two- and three-component scintillators as a function of concentration. Above a critical concentration, the transfer of the excitation energy from the solvent benzene to the molecules of the primary scintillators (p-terphenyl, 2,5-diphenyloxazole, and 2-phenyl-5-(4-biphenylyl)-1,3,4-oxadiazole) occurs by a quantum mechanical resonance exchange, in a limited concentration range below the critical concentration, by intermolecular collisions. The molecules of the secondary scintillators (1,4-di(2-(5-phenyloxazolyl))-benzene, 1,6-diphenyl-1,3,5-hexatriene, p-quaterphenyl, anthracene, and 1,1,4,4-tetraphenyl-1,3-butadiene) absorb the photons emitted by the primary scintillator and emit their own fluorescence radiation with characteristic spectra distribution from the scintillator system. (tr-auth)

464 INCREASING THE DISCRIMINATING CAPACITY OF NUCLEAR EMULSIONS BY SUPERPROPORTIONAL AMPLIFICATION. A. P. Zhdanov, L. I. Shur, and G. G. Martysh. Zh. Nauchn. i Prikl. Fotogr. i Kinematogr., 9: 111-14(1964).

Superproportional mercury amplifiers, consisting of bleaching and blackening solutions were used to study and discriminate ionization trails. The bleach solution contained 100 ml water, 5 g mercuric chloride, and 5 g potassium bromide. The darkening solution had sodium sulfide, hydroquinine, potassium bromide, and water. For optimum results both solutions were used in a 1:1 concentration ratio. Curves were obtained of blackening density as a function of exposure to α and β radiation. In all cases a superproportional increase in blackening density was noticed. To study the intensification effect on various ionization trails of particles, the plates were irradiated with α particles from ^{210}Po and protons recoiling from neutrons. A plot was also obtained for track width N versus depth of layer on the surface and at the wall during intensification, after intensification at 4°C, and after intensification at 20°C. The largest width was obtained for the 20°C intensification. (OTS)

465 RADIORESISTANCE OF A SERIES OF AROMATIC MOLECULES IN THE SOLID STATE. Claudine Williams-Dorlet, Jules Duchesne, and Marcel Lacroix (Université, Liège). p.127-30 of "Electronic Aspects of Biochemistry." New York, Academic Press, 1964.

The yields of free radicals from ^{60}Co irradiation of a series of condensed polynuclear aromatic molecules are studied, using an ESR method. The molecules irradiated are azulene, naphthalene, anthracene, phenanthrene, pyrene, and chrysene. It is concluded that the degree of resonance energy per π electron determines the extent of radioresistance of solid matter, and that the position of the first-excited singlet state is also roughly indicative of the radioresistance. (T.F.H.)

466 RADIORESISTANCE OF SOLID CONJUGATED MOLECULES. Bernard Pullman (Université, Paris). p.131-4 of "Electronic Aspects of Biochemistry." New York, Academic Press, 1964.

It is noted that the resonance energy per π electron in solid cyclic organic compounds is a more valid index of the radioresistance of these compounds than is the position of the first excited state of the compounds. It is further noted that a correlation seems to exist between the resonance energies in the ground and first-excited states of such molecules. This correlation is tabulated for the compounds uracil, thymine, cytosine, guanine, and adenine. It is noted that the resonance energy is also a more valid index of radioresistance than diamagnetic anisotropy. (T.F.H.)

467 SCINTILLATION PROPERTIES OF LIQUIDS. Sanford Lipsky (Univ. of Minnesota, Minneapolis). p.215-32 of "Physical Processes in Radiation Biology." New York, Academic Press, 1964.

The efficiency of nonradiative electronic energy transfer from the liquids benzene, toluene, p-xylene, and mesitylene to p-terphenyl is presented both for ultraviolet excitation in the first three absorption bands and for ^{137}Cs gamma excitation. In addition, the efficiency with which bromobenzene and oxygen interfere with the transport process is discussed. For both modes of excitation, the transferring state is concluded to be the lowest electronically excited singlet state of the solvent. For optical excitation, the overall transfer quantum yield is expressible as a product of two quantum efficiencies, experimentally separable: the efficiency with which upper states of the solvent internally convert to the lowest singlet, the transferring state, and the efficiency with which this latter state transfers energy to the solute. Possible mechanisms for the energy transfer process are reviewed. Evidence derived from solvent dilution experiments suggests that molecules of the bulk solvent participate in the transfer from the initial region of energy absorption to the solute but a weak coupling description of this process seems inadequate. The mechanism of energy transport involved in the primary act of photosynthesis and discussed by Professor Rabinowitch at this conference may be similar to that occurring in these liquid aromatic hydrocarbons. For ^{137}Cs gamma excitation, the relative efficiency for the production of transferring states has been obtained for the liquid aromatics and found to increase in the order benzene, toluene, p-xylene, and mesitylene. This same order is predicted from Born Approximation estimates of the relative cross-sections for production of electronically excited states and from the known internal conversion efficiencies from the upper states to the lowest excited singlet. However, the results of the calculation suggest that the low lying singlet states are produced directly with higher efficiency (relative to the upper state) than predicted from their relative oscillator strengths. Presumably low energy electrons and/or ion plus electron recombinations contribute significantly to the production of transferring states. (auth)

468 REACTIVE SPECIES IN THE IRRADIATION OF WATER AND AQUEOUS SYSTEMS. Joseph J. Weiss (King's Coll., Newcastle-upon-Tyne, Eng.). p.233-45 of "Physical Processes in Radiation Biology." New York, Academic Press, 1964.

The chemical effects of ionizing radiation on aqueous systems are discussed in relation to: hydrogen atoms and OH radicals; radioinduced formation of polarons; and excited water molecules. (H.M.G.)

469 EVIDENCE FOR THE HYDRATED ELECTRON FROM OPTICAL ABSORPTION AND ELECTRICAL CONDUCTIVITY MEASUREMENTS. J. W. Boag (Mount Vernon Hospital, Northwood, Middx., Eng.), G. E. Adams, and E. J. Hart. p.247-52 of "Physical Processes in Radiation Biology." New York, Academic Press, 1964.

Experiments are described that indicate the transient species formed by the irradiation of water possess similar

properties and are identified as hydrated electrons. The search for transient species in aqueous solutions was conducted by using pulsed radiolysis coupled with optical absorption spectroscopy. (H.M.G.)

470 MECHANISM OF THE ACTION OF RADIATIONS ON SOLID ORGANIC COMPOUNDS. V. V. Voevodskii. p.71-104 of "Actions Chimiques et Biologiques des Radiations. Sixieme Serie." Paris, Masson et Cie Editeurs, 1963. (In French)

The utilization of electron paramagnetic resonance for studies on the mechanism of radiation effects on solid organic compounds is reviewed. The hypothesis of the determinant role of free radicals in the chemical mechanism of radiolysis is used to construct a catalog of the processes taking place. The primary rupture of C–H bonds, the possibility of a primary radiolytic rupture of C–C bonds, secondary reactions of hydrogen atoms, site of the initial detachment of the hydrogen atom, energy transfer, G_R values for irradiated organic systems, and hot atoms in the radiolysis of hydrocarbons are discussed. 55 references. (J.S.R.)

471 RADIATION CHEMISTRY. Proceedings of the September 16-20, 1962 Tihany Symposium. Budapest, Publishing House of the Hungarian Academy of Sciences, 1964. 482p. $14.00.

Proceedings of the Tihany Symposium on Radiation Chemistry are presented. Separate abstracts were prepared for 48 of the 50 papers included. The two remaining papers were previously abstracted for NSA and appeared as abstracts 17: 4578 and 18: 10588. (M.C.G.)

For abstracts of individual papers see: 338, 472, 473, 474, 475, 476, 477, 478, 479, 480, 481, 482, 483, 484, 485, 486, 487, 488, 489, 490, 491, 492, 493, 494, 495, 496, 497, 498, 499, 500, 501, 502, 503, 504, 505, 506, 507, 508, 509, 510, 511, 512, 513, 514, 515, 516, 840, and 862.

472 RADIATION-CATALYTIC CHLORINATION OF CYCLOPENTADIENE DERIVATIVES. A. Almásy and V. Rőna (Research Inst. of Heavy-Chemical Industries, Veszprém, Hungary). p.17-21 of "Radiation Chemistry." Budapest, Publishing House of the Hungarian Academy of Sciences, 1964.

Experiments were carried out on the further chlorination of tetrachlorocyclopentane to octachlorocyclopentene in the liquid phase with the aid of radiation catalysis using a ^{60}Co radiation source. It was found that it is possible to conduct chlorination at 170°C in the liquid phase when a dose rate of 10^3 to 10^5 r/hr is used. At an optimum dose rate the time required for the reaction is 15 to 16 hr. In this case practically 100% conversion occurs via a radical mechanism. (M.C.G.)

473 RADIATION SULPHOXIDATION OF n-HEXANE. D. Bertram (Central Inst. of Nuclear Physics, Rossendorf, Ger.). p.23-30 of "Radiation Chemistry." Budapest, Publishing House of the Hungarian Academy of Sciences, 1964.

The effects of temperature and dose rate on the radioinduced sulfoxidation of n-hexane were studied: A 200-kev x-ray apparatus served as radiation source. The course of the reaction was qualitatively the same at all temperatures from 0 to 60°C. The reaction rate increased with increasing radiation dose rate. Data are presented in tables and graphs. (M.C.G.)

474 IONIC MECHANISMS IN THE RADIATION CHEMISTRY OF SOME UNSATURATED COMPOUNDS. W. G. Burns (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.31-44 of "Radiation Chemistry." Budapest, Publishing House of the Hungarian Academy of Sciences, 1964.

Studies of the radiation chemistry of α-pinene, β-pinene, α-methylstyrene, and cyclopentadiene are described. On irradiation of α-pinene with fast electrons or gamma rays, a gas consisting mainly of hydrogen, isomers of similar volatility to the original substance, and a polymer of mean molecular weight three times that of the monomer were produced. An ionic mechanism to explain these results is postulated. The predominant reaction of β-pinene under gamma irradiation was the formation of a polymer, whose extent was proportional to dose up to 60% conversion. Studies indicated an ionic mechanism in the polymer formation involving rearrangement of the parent ion followed by electron capture at the radical site to give an internal ion pair. The gamma-induced polymerization of α-methylstyrene took place at 30°C with a value of 8000 for G(–M). The importance of chain transfer and the inhibition caused by water were good evidence of an ionic mechanism. Irradiation of cyclopentadiene with gamma rays at –78°C induced a rapid polymerization with G ~ 18,000. The low temperature of the reaction and the fact that it was strongly inhibited by water indicated an ionic mechanism. (M.C.G.)

475 SOLID-STATE RADIATION CHEMICAL OXIDATION. M. Durup, R. Marx, and H. Szwarc (Université de Paris, Orsay, France). p.45-9 of "Radiation Chemistry." Budapest, Publishing House of the Hungarian Academy of Sciences, 1964.

Solid-state radioinduced oxidation of benzene, toluene, cumene, cyclohexane, iso-octane, t-butanol, and styrene was studied. The samples were irradiated at 77°K with ^{60}Co gamma rays at dose rates from 100 to 18000 R/min. Then the electron spin resonance (ESR) spectra were measured at temperatures from 77°K to the compounds' melting points. At liquid nitrogen temperature the spectrum obtained for each compound irradiated in the presence of oxygen was identical with that obtained for the degassed sample. It can be interpreted as due to the radical obtained by hydrogen abstraction. When the samples containing oxygen were warmed up, in some compounds (cumene, acrylonitrile, and ethyl alcohol) the ESR spectrum of the alkyl radicals was entirely transformed into a spectrum attributed to $RO_2 \cdot$ radicals, for the other compounds (cyclohexane, iso-octane, benzene, and toluene) the spectrum remained unchanged. In the case of tert-butyl alcohol, the spectrum changed to a form that may correspond to an $RO_2 \cdot$ radical. When the formation of $RO_2 \cdot$ radicals was observed, it seemed to occur at the solid-state phase transition temperature, and the radicals disappeared without any chain reaction taking place. (M.C.G.)

476 RADIOLYTIC OXIDATION OF PARAFFIN WAX AND OTHER HYDROCARBONS. RADIATION-INDUCED POLYMERIZATION AND COPOLYMERIZATION OF LOW MOLECULAR WEIGHT OLEFINS. Y. L. Khmelnitski, V. V. Nesterovski, I. I. Melekhonova, E. M. Kononova, and V. M. Nikitina (All-Union Inst. for Scientific Research on Oil Refining, Moscow). p.52-65 of "Radiation Chemistry." Budapest, Publishing House of the Hungarian Academy of Sciences, 1964.

Experiments were carried out on the radiolytic liquid-phase oxidation by air of a technical grade paraffin wax of petroleum origin. Radiation intensities of 215 and 455 R/sec from a ^{60}Co gamma source were used at 120 to 160°C. The formation rates of non-evaporating carboxylic acids at both dose rates exhibited a distinct maximum near 150°C. Increasing the intensity of gamma-irradiation resulted in a considerable increase in the acid number, hydroxyl number, and carbonyl number of the oxidation product. Radiolytic oxidation of p-xylene, diethylbenzene, and 1-decene was also studied. The longer the side chains of an aromatic hydrocarbon, the lower its resistance to oxygen in the presence of gamma radiation. Compounds containing carbonyl groups were the main products of the radiolytic oxidation of diethylbenzene. Compounds containing hydroxyl groups were the main products of the radiolytic oxidation of 1-decene. Experiments were also carried out on the radioinduced polymerization of propylene and isobutylene, using a ^{60}Co gamma source. (M.C.G.)

477 RADIATION CHEMISTRY OF BIPHENYL AND DIPHENYLMETHANE MIXTURES. I. Kiss, I. Kósa-Somogyi, I. Kules, R. Schiller, R. Gróh, and M. Vizesy (Central Research Inst. of Physics, Budapest). p.67-74 of "Radiation Chemistry." Budapest, Publishing House of the Hungarian Academy of Sciences, 1964.

In an investigation of the radiolysis of the biphenyl–diphenylmethane system at various concentrations, exposed to the mixed radiation of a nuclear reactor, the gas product yield, the decrease in concentration of initial compounds, and the variation in viscosity were analyzed in terms of the dose absorbed by both individual components and their mixtures. The gas production and the overall radiolytic transformation rates were found to be approximately the same for the components in a pure state as in their mixtures, i.e., neither appreciable inhibition nor sensitivization could be observed. The results of viscosity measurements seemed to indicate the radiolytic polymers involved to be of an approximately spherical shape. (auth)

478 INTERCEPTION OF RADICALS BY ANTHRACENE AND ITS HOMOLOGUES IN THE RADIOLYSIS OF HALOGENATED HYDROCARBONS. J. Laplane-Masanet and N. Ivanoff (Universite de Paris, Orsay, France). p.75-8 of "Radiation Chemistry." Budapest, Publishing House of the Hungarian Academy of Sciences, 1964.

To determine whether anthracene and its homologs are scavengers of radicals produced by the radiolysis of halogenated hydrocarbons, solutions of anthracene, 1,2-benzanthracene, 9-chloranthracene, and napthacene were irradiated in carbon tetrachloride with gamma rays. Solutions of anthracene and diphenylpicrylhydrazyl in bromotrichloromethane, methylchloroform, and methanol were investigated in the same way. The consumption of scavengers was measured by spectrophotometry at intervals during irradiation. The polyaromatic compounds studied seemed to behave as scavengers in all the solvents studied. (M.C.G.)

479 RECENT DEVELOPMENTS IN RADIATION CHEMISTRY AT WANTAGE RESEARCH LABORATORY. R. Roberts (Atomic Energy Research Establishment, Wantage, Berks, Eng.). p.79-86 of "Radiation Chemistry." Budapest, Publishing House of the Hungarian Academy of Sciences, 1964.

Studies of the radiolysis of methane by 4-Mev electrons showed that at methane conversions exceeding 15% liquid products are formed. The bulk of these appeared to be hydrocarbons possessing from 14 to 20 carbon atoms. In order to investigate the ionic mechanisms the system of methane–argon was studied. The G value for hydrogen production was increased in the presence of argon above the figure for pure methane. Studies indicated that the extra hydrogen results from the charge transfer process leading to extra CH_3^+ ions. The radioinduced cross-linking of natural and synthetic rubbers is also being studied. The vulcanizate produced in this way was found to have a tensile strength inferior to that obtained by using sulfur vulcanization. Liquid-phase radioinduced oxidation of xylene was studied. For dose rates of 8×10^{17} ev/l sec, the rate of oxidation was 3.6×10^{-8} mole/l sec. Bromoörganic compounds and hydrogen bromide were found to accelerate the rate of oxidation. Experiments on the radiolysis of sugar solutions indicated little difference in the extent of damage to glucose solutions between heat and radiation sterilization. Protective effects of sodium ascorbate and thiourea are being studied. (M.C.G.)

480 RADIOLYTIC TRANSFORMATION OF VARYING-VALENCY METAL IONS DISSOLVED IN ACETONE. M. Roder and N. A. Bach (Central Research Inst. of Physics, Budapest and Moscow State Univ.). p.87-97 of "Radiation Chemistry." Budapest, Publishing House of the Hungarian Academy of Sciences, 1964.

Inorganic compounds containing elements of varying valency were used as solutes for investigating the radiolysis of acetone. The compounds used were $FeCl_2$, $FeCl_3$, $CuCl_2$, Cu_2Cl_2, $CrCl_3$, CrO_3, KI, and I_2. The radiolytic transformations of these compounds were analyzed in terms of absorbed dose, concentration and kind of saturation gas. X-ray equipment was used as the radiation source. It was found that on irradiating inorganic compounds containing elements of varying valency when dissolved in acetone, redox processes may be induced by the radiolytic products of the solvent. (M.C.G.)

481 THE EFFECT OF NAPHTHALENE CONCENTRATION ON THE RADIATION YIELD OF HYDROGEN IN DE-AERATED NEDA AND NETA SOLUTIONS. W. Stachowicz and Z. Kecki (Inst. of Nuclear Research, Warsaw). p.99-102 of "Radiation Chemistry." Budapest, Publishing House of the Hungarian Academy of Sciences, 1964.

In the course of study on radiation behavior of some organic materials, which can be obtained from the 180 to 210°C fraction of petroleum, a set of experiments with a solution of naphthalene in NEDA and NETA was carried out. NEDA and NETA are solvents obtained from that fraction of petroleum. A protective action of naphthalene was observed in both solutions. (M.C.G.)

482 SOME RECENT WORK IN ORGANIC RADIATION CHEMISTRY AT IMPERIAL COLLEGE. A. J. Swallow (Imperial Coll. of Science and Tech., London). p.103-9 of "Radiation Chemistry." Budapest, Publishing House of the Hungarian Academy of Sciences, 1964.

In studies of radiation protection by aromatic compounds, mixtures of cyclohexane and benzene were irradiated with gamma rays and polymer yields measured. An explanation of the sponge type protection of cyclohexane by benzene is offered. The work on protection by aromatic compounds was also extended to solutions. The effects of oxygen and hydrogen peroxide on gamma irradiation of aqueous solutions of tryptophan were studied and found to be the same as obtained by irradiating tryptophan with alpha particles. Radiation was found to speed up the methylation of aromatic compounds in a steam-bath mixture. Dilute aqueous solutions of carbon monoxide were irradiated with gamma rays and formic acid. Formaldehyde, and some other organic compounds were formed. (M.C.G.)

483 MECHANISM OF RADIATION EFFECTS ON ORGANIC SOLIDS. V. V. Voevodski (Inst. of Chemical Kinetics, Novosibirsk, USSR). p.111-45 of "Radiation Chemistry." Budapest, Publishing House of the Hungarian Academy of Sciences, 1964.

Some experimental data obtained from the radiolysis of solid organic compounds were analyzed. The general methods of studying free radicals formed by irradiation from considerations based on electron paramagnetic resonance measurements are reviewed. Topics covered include: the radical component of radiolysis, G_R, radical structures, primary rupture of C–H bonds by radiolysis of organic compounds, possibilities of primary C–C bond ruptures by radiolysis, destruction of polymers by irradiation, place of primary abstraction of H atoms, energy transfer in radiolysis, radical yield in irradiation of organic systems, and formation of hot atoms by radiolysis of hydrocarbons. (M.C.G.)

484 RADIOLYSIS OF LIQUID CHLOROBENZENE BY Co^{60} GAMMA-RADIATION. J. Wendenburg and A. Henglein (Hahn-Meitner Inst. of Nuclear Research, Berlin). p.147-9 of "Radiation Chemistry." Budapest, Publishing House of the Hungarian Academy of Sciences, 1964.

Yields from the radiolysis of liquid chlorobenzene at 28°C are reported. Evidence was obtained for both a free radical mechanism and a fast molecular process. (M.C.G.)

485 RADIATION- AND PHOTOCHEMICAL POLYMERIZATION AND CO-POLYMERIZATION OF ACRYLONITRILE IN THE SOLID STATE. R. V. Bensasson, A. Bernas, M. Bodard, and R. Marx (Universitè de Paris, Orsay. France). p.153-62 of "Radiation Chemistry." Budapest, Publishing House of the Hungarian Academy of Sciences, 1964.

Supplementary information about kinetic discontinuities observed for radioinduced polymerization reactions in acrylonitrile molecular crystals at temperatures corresponding to phase transitions is presented. The importance of crystallization conditions is stressed. The mechanism of acrylonitrile solid-state polymerization is considered to be of a radical nature. It is shown that, under irradiation, chemical reactions may occur involving substances that do not necessarily syncrystallize. (auth)

486 COMPARISON OF ALPHA-, GAMMA- AND ULTRA-VIOLET EFFECTS IN IRRADIATED POLYETHYLENE UNSATURATION CHANGES. A. Charlesby (Royal Military College of Science, Swindon, Eng.). p.175-83 of

"Radiation Chemistry." Budapest, Publishing House of the Hungarian Academy of Sciences, 1964.

The changes produced in polyethylene by exposure to ultraviolet and alpha radiation were investigated and compared with previous results obtained with gamma and electron irradiation. Changes in unsaturation in this polymer were studied. When polyethylenes are subjected to gamma or electron radiation, the main reactions previously reported are: cross-linking, degradation, increase in transvinylene unsaturation, and decrease in vinyl and vinylidene unsaturation. It was found that ultraviolet radiation plus a sensitizer produce transvinylene unsaturation as readily as gamma radiation or electrons. In alpha irradiation the degree of transvinylene unsaturation tended to a much higher maximum (10^{-3} mole/g) than with gamma rays and electrons. (M.C.G.)

487 EFFECT OF ADDITIVES ON THE LOW-TEMPERATURE Co^{60}-INITIATED POLYMERIZATION OF ISOBUTENE. F. L. Dalton (Wantage Research Lab., Harwell, Berks, Eng.). p.185-93 of "Radiation Chemistry." Budapest, Publishing House of the Hungarian Academy of Sciences, 1964.

Attempts are being made to determine whether or not isobutene can be polymerized homogeneously at low temperature by radiation. Zinc oxide is being used as the additive and ^{60}Co as the gamma source. All polymerizations were carried out at −78°C in a bath of trichloroethylene and solid carbon dioxide. Results are shown in graphs. (M.C.G.)

488 GRAFTING OF STYRENE ONTO PRE-IRRADIATED TEFLON. J. Dobó and Á. Somogyi (Research Inst. of Plastics Industry, Budapest). p.195-203 of "Radiation Chemistry." Budapest, Publishing House of the Hungarian Academy of Sciences, 1964.

Teflon film, previously irradiated in air, was grafted with styrene. The grafting was followed dilatometrically and controlled by weight at the end of the experiment. The curves were corrected for styrene homopolymerization. As judged from the homopolymer content, chain transfer to the monomer had no determining effect on the amount of grafting. Three distinct portions were exhibited by the curves: an induction period, a linear ascending portion, and a flattened portion in which the grafting practically reaches a limiting value. Application of ordinary homogeneous phase kinetics gave a fair approximation to the treatment of trapped free-radical pre-irradiation grafting. The rate constant of termination had a similar or lower absolute value and a higher activation energy than that of propagation. Initiation corresponded to the diffusion of monomer into the ungrafted parts of the polymer, and the limiting value of grafting corresponded to the post-polymerization on the free radicals of given concentration. (M.C.G.)

489 RADIATION-INDUCED POLYMERIZATION IN THE LIQUID AND IN THE SOLID STATE. G. Hardy (Research Inst. for the Plastics Industry, Budapest), K. Nyitray, G. Kovács, N. Fedorova, and J. Varga. p.205-17 of "Radiation Chemistry." Budapest, Publishing House of the Hungarian Academy of Sciences, 1964.

Radiation polymerization kinetics of cetyl methacrylate, N-vinylcaprolactam, and N-vinylsuccinimide were investigated in the liquid and solid state. Each monomer exhibited different temperature dependence of the rate of polymerization. This can result from the difference in the crystalline structures (different orientation of the monomer molecules in the lattice was indicated). The polymerization of N-vinylcaprolactam was more rapid in the supercooled state than in the liquid one. The solid-state polymerization of N-vinylsuccinimide may lead to a thermal explosion at certain temperatures and radiation doses. (auth)

490 KINETICS OF RADIATION POLYMERIZATION. W. Holzmueller (Inst. of Physics and Chemistry of High Polymers, Leipzig). p.219-24 of "Radiation Chemistry." Budapest, Publishing House of the Hungarian Academy of Sciences, 1964.

Kinetics and economics of polymerization processes induced by electrons and x rays are being studied. Vinyl chloride and vinylidene chloride were exposed to x rays. Kinetics for radical-chain polymerization by formation of free radicals, chain growth, and chain termination are discussed. (M.C.G.)

491 RADIATION POLYMERIZATION OF ACRYLONITRILE AT LOW TEMPERATURES. L. Kiss, A. N. Pravednikov, and S. S. Medvedev (Karpov Inst. of Physics and Chemistry, Moscow). p.225-33 of "Radiation Chemistry." Budapest, Publishing House of the Hungarian Academy of Sciences, 1964.

A reactor was designed for studying the macro-ions that initiate the low-temperature polymerization of acrylonitrile. The temperature of the reactor can be kept constant within 0.5%. The design permits the study of the effects of a d-c electric field on radioinduced polymerization. An inhibiting effect of the d-c field was found on the low-temperature radiation polymerization in block and in solutions. The d-c field was proved to sensitize the radical polymerization of acrylonitrile initiated by azo-bis-isobutyronitrile at 50°C. The presence of acrylonitrile macro-ions was proved in low-temperature radiation polymerization of acrylonitrile in dimethylformamide solution using a polarographic technique, at a half-wave potential of 1.26 v on the first polarographic step. On the basis of the results obtained it was concluded that the low-temperature radiation polymerization of acrylonitrile is initiated by isolated ions. (auth)

492 RADIATION-CHEMICAL TRANSFORMATION OF ELASTOMERS. A. S. Kuzminski, E. V. Zhuravskaya, L. I. Lyubchanskaya, and L. S. Feldstein (Research Inst. of the Rubber Industry, Moscow). p.235-43 of "Radiation Chemistry." Budapest, Publishing House of the Hungarian Academy of Sciences, 1964.

Investigations were made of the stress-relaxation of compressed samples of elastomers using an axial relaxometer. Cylindrical samples were placed in special metallic holders and irradiated in the deformed state. Stress was measured at definite time intervals and the samples were deformed 50%. The samples were kept under deformation for several days before irradiation with gamma rays from a ^{60}Co source. The kinetics of chemical relaxation and the rate of accumulation of the permanent set were investigated. The change of equilibrium moduli during radiation aging was determined. The stress-relaxation of compressed elastomers was found to be the same as that of stretched ones provided oxygen was excluded. Irradiating in air changed this condition. An intensive ozone cracking was found in elongated rubbers simultaneously with the process of aging. Aromatic amines, aromatic disulfides, quinolines, and other compounds could be used to increase the radiation resistance of rubbers. (M.C.G.)

493 SOME IMPORTANT FACTORS IN THE RADIATION TREATMENT OF NATURAL RUBBER LATEX. A. Lamm and G. Lamm (Centre of Nuclear Research, Saclay, France and Laboratory of Rubber Control and Research, Paris). p.245-53 of "Radiation Chemistry." Budapest, Publishing House of the Hungarian Academy of Sciences, 1964.

The influence of chloroform on the mechanical properties of carbon black reinforced latex and the aging and electrical properties of latex film obtained by irradiating latex and aqueous carbon black dispersions, mixing, and drying was studied. Gamma dose rates from ^{60}Co sources of 75,000 to 100,000 r/hr were used. The radiation dose for maximum tensile was diminished by a factor of 10 by use of chloroform, but the maximum tensile strength was somewhat lower. Irradiation increased the electric conductivity of the latex. Colloidal silica was also studied as a filler in irradiated latex. (M.C.G.)

494 GAMMA-RAY-INDUCED GRAFTING ON POLYPROPYLENE. L. Ódor and F. Geleji (Research Inst. for Plastics Industry, Budapest). p.255-60 of "Radiation Chemistry." Budapest, Publishing House of the Hungarian Academy of Sciences, 1964.

Irradiation with gamma rays was chosen to study the

mechanism of grafting onto polypropylene. Studies were made on foils, monofilaments, or fibers. The grafting medium was a 50% solution of acrylic acid in water. Ferrous sulfate was used to inhibit homopolymerization of the monomer. Methyl methacrylate was also used in some experiments. It was found that samples irradiated with lower intensities could be grafted for higher percentage. The grafting was not limited to a surface layer. (M.C.G.)

495 INFLUENCE OF INORGANIC ADDITIVES ON THE RADIATION-INDUCED VULCANIZATION. A. Országh and Z. Smigasiewicz (Inst. of Nuclear Research, Warsaw). p.261-71 of "Radiation Chemistry." Budapest, Publishing House of the Hungarian Academy of Sciences, 1964.

Experiments were carried out to investigate the accelerating effect of zinc and cadmium salts on radioinduced vulcanization. Irradiations were carried out in nitrogen atmosphere using ^{60}Co source. The dose rate was about 100 R/sec. The degree of cross-linking and the equilibrium volume swell in benzene were determined. Results are shown in graphs. The cadmium and zinc compounds had an accelerating effect, with that of cadmium greater than that of zinc. (M.C.G.)

496 RADIATION GRAFTING OF 4-VINYLPYRIDINE ONTO PVC FIBERS. H. Roudeix (Centre of Nuclear Research, Saclay, France). p.273-82 of "Radiation Chemistry." Budapest, Publishing House of the Hungarian Academy of Sciences, 1964.

Radioinduced grafting of 4-vinylpyridine onto polyvinyl chloride fibers in order to improve their tinctorial properties is discussed. Skeins of about 5 g of fibers were put with 80 ml of vinylpyridine solution in glass ampoules, which were than outgassed. The ampoules were then irradiated using a 600-C ^{60}Co source. When grafting was superficial and lower than 15 to 20% the fibers kept the aspect of new fibers, the flexibility and hand were not affected. They had a good aptitude for dyeing with acid and premetallized dyes. When fibers were grafted throughout the whole section they could not be dyed very well. (M.C.G.)

497 THE EFFECT OF LINEAR ENERGY TRANSFER ON RADIATION-INDUCED REACTIONS OF MACROMOLECULES IN SOLUTION. W. Schnabel, A. Henglein, Y. Kobayashi, and E. Heckel (Hahn-Meitner-Inst. of Nuclear Research, Berlin). p.283-6 of "Radiation Chemistry." Budapest, Publishing House of the Hungarian Academy of Sciences, 1964.

A comparison was made between the effects of ^{60}Co gamma rays (LET: 0.03 ev/Å or 10 ion pairs/μ) and $^{7}Li/^{4}He$ particles from the reaction $^{10}B(n,\alpha)^{7}Li$ (LET: 28 ev/Å or 10^4 ion pairs/μ) on polymers in solution. In all experiments the same absorbed dose rate was used and the solvent contained at least 50% of an ester of boric acid. Three linear energy transfer effects are discussed. (M.C.G.)

498 VULCANIZATION OF RUBBERS WITH SULPHUR AND IONIZING RADIATION. Z. N. Tarasova, V. T. Kozlov, and B. A. Dogadkin (Research Inst. of Rubber Industry, Moscow). p.287-300 of "Radiation Chemistry." Budapest, Publishing House of the Hungarian Academy of Sciences, 1964.

Experimental results are described showing that the effects of sulfur on the properties of rubbers vulcanized by radiation are favorable. On the basis of these results a method of combined radiation-thermal vulcanization was worked out. Results are shown in graphs. (M.C.G.)

499 RADIATION-INDUCED CHLORINATION AND CHLOROSULPHONATION OF POLYETHYLENE. L. Wuckel, L. Sawtschenko, and A. Seidel (Inst. of Applied Physics for High-Purity Materials, Dresden). p.301-6 of "Radiation Chemistry." Budapest, Publishing House of the Hungarian Academy of Sciences, 1964.

The chlorination and chlorosulfonation of insoluble polyethylene in the heterogeneous phase is described. The high penetration of ^{60}Co γ rays made it possible to initiate the reactions in big vessels from outside. The G-values were on the order of 10^5 to 10^6, confirming the process to be a chain reaction. (auth)

500 RADIATION-INDUCED SOLID-STATE COPOLYMERIZATION OF ACRYLAMIDE WITH METHACRYLAMIDE. Janina Zurakowska-Országh (Univ. of Warsaw). p.315-21 of "Radiation Chemistry." Budapest, Publishing House of the Hungarian Academy of Sciences, 1964.

Studies were made of the solid-state radioinduced copolymerization of acrylamide with methacrylamide for various initial weight ratios. Results are shown in graphs. A ^{60}Co gamma source was used in the irradiation. A systematic decrease of polymerization rate with an increase of the methacrylamide content in the irradiated system was observed. (M.C.G.)

501 SOME ASPECTS OF THE RADIATION CHEMISTRY OF CONCENTRATED AQUEOUS SOLUTIONS. J. Bednář (Inst. of Nuclear Research, Řež, Czechoslovakia). p.325-32 of "Radiation Chemistry." Budapest, Publishing House of the Hungarian Academy of Sciences, 1964.

Studies of the radiolysis of concentrated aqueous solutions of sodium nitrate are described. Gamma rays from ^{60}Co were used to irradiate the solutions. Primary mechanisms of radiolysis and secondary reactions of intermediates were determined. (M.C.G.)

502 TRANSFORMATIONS OF FERROUS AND FERRIC IONS IN AQUEOUS SOLUTIONS DIRECTLY OBSERVED DURING IRRADIATION WITH GAMMA RAYS. R. Broszkiewicz (Inst. of Nuclear Research, Warsaw). p.333-6 of "Radiation Chemistry." Budapest, Publishing House of the Hungarian Academy of Sciences, 1964.

Direct observations of iron ion transformations occurring in aqueous solutions proved experimentally that after complete consumption of oxygen, and probably after the destruction of peroxides, when the concentration of an organic compound is sufficiently high, the R radicals evolved are able to reduce the ferric ions formed and, with respect to iron, the whole process is reversed. The ferrous and ferric ions seemed to be carriers in processes involving organic and oxygen molecules. The processes were dependent on many factors, such as concentration of the reagent and probably dose rate. (auth)

503 INTERPHASE PHENOMENA IN THE RADIOLYSIS OF AQUEOUS SOLUTIONS. A. Călusaru and S. Ionescu (Inst. of Atomic Physics, Bucharest). p.337-52 of "Radiation Chemistry." Budapest, Publishing House of the Hungarian Academy of Sciences, 1964.

The radiolysis of solutions was studied in an irradiation system containing an ^{198}Au source (total activity 9 to 10 C), by dose rates of Mrad/hr. The apparatus provided full protection during work in the laboratory. It was found that when nickel hexammine solutions are irradiated, substances with lower co-ordination, mainly nickel tetrammine, are formed. In the course of radiolysis of solutions containing $NiSO_4$ 0.9×10^{-3}N, $(NH_4)_2SO_4$ 0.66N, NH_4OH 0.043N, and gelatin, 0.0066%, catalytical polarographic curves were obtained for which neither gelatin, its components, nor its usual decomposition products were responsible. The appearance of catalytic currents was considered due to the formation of substances containing active groups produced by irradiation in the presence of gold. The kinetics of the active substances were studied and the reaction found to proceed at a constant rate after an induction period. The rate constant for the formation of the intermediate products was $k_1 = 3.87 \times 10^{-6}$, for that of the final product $k_2 = 1.58 \times 10^{-2}$. (auth)

504 ROLE OF MOLECULAR PRODUCTS FORMED DURING THE IRRADIATION OF AQUEOUS SOLUTIONS IN ELECTRODE PROCESSES. P. I. Dolin, D. V. Kokolina, S. A. Brusentseva, and S. A. Kabakchi (Inst. of Electrochemistry, Moscow). p.353-9 of "Radiation Chemistry." Budapest, Publishing House of the Hungarian Academy of Sciences, 1964.

An investigation was made of the action of x rays on the potential of a Pt electrode in 0.8N H_2SO_4 to establish the effect of molecular and radical products on the electrode

potential. The potential of the Pt electrode was found to shift under irradiation, first in the negative direction by about 0.8 v to close to the reversible hydrogen potential and then rise again to about 0.85 v. The dose at which the potential came close to the hydrogen potential was about 4 to 5×10^{18} ev/cm^3. The action of x rays on the kinetics of the electrochemical process in anodic oxidation of formic acid and ethyl alcohol was also studied. It was found that decisive roles in the electrochemical process are played by molecular products from the radiolysis of water and stable products formed from the dissolved substance on change in potential. (M.C.G.)

505 MOLECULAR AND FREE-RADICAL YIELDS OF THE RADIOLYSIS OF WATER IN ALKALINE SOLUTIONS. M. Haissinsky (Université. Paris). p.361-3 of "Radiation Chemistry." Budapest, Publishing House of the Hungarian Academy of Sciences, 1964.

Yields from the radiolysis of water in alkaline media were studied by irradiating a 0.2N NaOH solution of Te^{4+} with ^{60}C gamma rays, in the presence and absence of oxygen. In the first case tellurous ions were oxidized to telluric ions with an initial yield that increased with concentration. In de-aerated solutions the yield of telluric ions was much less (5.8 : 0.18). It was found that yields tend to decrease with increasing pH except for G_{OH}, which appeared to increase on passing from the neutral medium to the alkaline solution. (M.C.G.)

506 MECHANISM OF THE RADIOLYSIS OF SOME ALIPHATIC AMINO ACIDS. J. Kopoldová, I. Liebster, and A. Babicky (Inst. for Biological Research, Prague). p.365-8 of "Radiation Chemistry." Budapest, Publishing House of the Hungarian Academy of Sciences, 1964.

Studies of radiolysis of amino acids in aqueous solutions are described. Irradiations were carried out in glass ampoules using a 400-C ^{60}Co source. The main decomposition products were analyzed by paper chromatography or by electrophoresis. The rate of decomposition was measured. Irradiated solutions of α-aminobutyric acid, norvaline, valine, leucine, norleucine, and isoleucine were analyzed. The rate of decomposition for all of them was found to be 20% less when irradiated in nitrogen than in oxygen. The total amount of radiolytic products was also less. (M.C.G.)

507 RADIOLYTIC OXIDATION AND REDUCTION IN SULPHUR COMPOUNDS. E. M. Nanobashvili and S. Gvilava (Inst. of Applied Chemistry and Electrochemistry, Moscow and Tbilisi, Georgian SSR). p.369-75 of "Radiation Chemistry." Budapest, Publishing House of the Hungarian Academy of Sciences, 1964.

Radiolytic oxidation and reduction of sulfides, rhodanides, mercaptans, thiourea, thiophene, and thiophenols were investigated and some of the results are reported. (M.C.G.)

508 A CHAIN-RADIOLYTIC OXIDATION MECHANISM IN AQUEOUS SOLUTIONS. V. D. Orekhov (Inst. of Fine Chemical Tech., Moscow). p.377-84 of "Radiation Chemistry." Budapest, Publishing House of the Hungarian Academy of Sciences, 1964.

Kinetic data for a chain radiolytic oxidation mechanism were obtained by irradiation of an oxygen-saturated acidic aqueous solution of leucoindigosol containing sodium nitrate. In the absence of oxygen the fundamental radiolytic reaction (decomposition of water) was followed by a number of reactions leading to the formation of the dye. The system reached a steady state in a small fraction of a second. The process had additional steps in the presence of oxygen. The effect of dissolved molecular oxygen on the rate of pigment formation was described by a term directly proportional to the concentration of oxygen in the solution, and proportional to the dose rate squared. (M.C.G.)

509 RADIOLYSIS OF WATER IN THE PRESENCE OF WATER-SOLUBLE FREE RADICALS. G. Putirskaya and I. Matus (Central Research Inst. for Chemistry, Budapest). p.385-94 of "Radiation Chemistry." Budapest, Publishing House of the Hungarian Academy of Sciences, 1964.

By measuring the radiation chemical conversion of water and with the assistance of stable free radicals (p,p-disulfo-α,α-diphenyl-β-picrylhydrazyl) it was possible to determine the quantity of the free radicals produced during irradiation with satisfactory certainty. According to previous calculations, about 5% of all the free radicals recombines in the spurs of the low-LET radiation with the simultaneous occurrence of molecular products. It is shown that this value depends only to a very small extent on the concentration of acceptors brought into the system. Taking into account this value of 5%, the total quantity of free radicals can be calculated as $G_{(H)} + G_{(OH^*)} + G_{(H_2)} + G_{(H_2O_2)} = 10.5$ radicals/100 ev, i.e., $G_{(-H_2O)} = 5.25$ molecules/100 ev. It followed that, besides the free radicals produced from the ionized molecules, the radicals originating from the excited H_2O molecules also take part in the process. Examination of the effects produced by concurrent acceptors on the radiolysis of water showed both types of radicals to be produced in nearly equal quantities. Spectroscopic investigation of the end products of stable free radicals made it possible to ascertain that these products originate as a result of the reaction between the stable free radicals and H atoms and OH radicals, as the products of the radiolysis of water. (auth)

510 POST-EFFECTS OF GAMMA- AND ELECTRON-PULSE IRRADIATION ON AQUEOUS SOLUTIONS OF $FeSO_4$, H_2SO_4 AND C_2H_5OH. L. Stolarczyk (Inst. of Nuclear Research, Warsaw). p.395-403 of "Radiation Chemistry." Budapest, Publishing House of the Hungarian Academy of Sciences, 1964.

Prolonged radioinduced oxidation of iron(II) in acid, air-saturated solutions containing small amounts of ethanol was observed. Prolongation of the oxidation after irradiation was enhanced by the ethanol addition and the yield of iron(III) was increased. Electrons and gamma rays were used in the irradiation. (M.C.G.)

511 NEW EXPERIMENTS IN THE RADIATION CHEMISTRY OF AQUEOUS ALKALINE SOLUTIONS. Z. P. Zagorski (Inst. of Nuclear Research, Warsaw). p.405-10 of "Radiation Chemistry." Budapest, Publishing House of the Hungarian Academy of Sciences, 1964.

Studies of the radiolysis of alkaline solutions to determine possible formation of H_2O_2 and H_2 are described. Polarography was carried out during irradiation. No detectable level of constant H_2O_2 concentration was observed. Without a scavenger the yields of H_2 were erratic, small, and dependent on the total dose absorbed. With a scavenger the G_{H_2} values varied from 0.50 to 2.8 depending on pH. (M.C.G.)

512 THERMOLUMINESCENCE OF GAMMA-IRRADIATED CRYSTALLINE QUARTZ. A. Deroulede, F. Kieffer, P. Obegi, and L. Ter Minassian (Universite de Paris, Orsay, France). p.413-19 of "Radiation Chemistry." Budapest, Publishing House of the Hungarian Academy of Sciences, 1964.

Natural quartz was found to emit visible thermoluminescence when heated after irradiation with ^{60}Co γ rays. Glow curves obtained with a heating rate of about 10°C/min showed that the numbers and positions of peaks vary, even for the same sample, according to dose received, previous irradiations, and annealing by heatings. For high doses, glow curves were reproducible. For low doses, they could be made reproducible by three treatments described. The relationship between radioinduced coloration and thermoluminescence of quartz was examined. A tentative interpretation of the facts observed is given. (auth)

513 RADIATION-CHEMICAL CRACKING OF HYDROCARBONS SUBJECTED TO AN ELECTRIC FIELD. G. Foeldiák and Z. Paál (Hungarian Oil- and Gas-Research Inst., Budapest and Veszprém, Hungary). p.421-6 of "Radiation Chemistry." Budapest, Publishing House of the Hungarian Academy of Sciences, 1964.

By the effects of silent electric discharge and at high temperatures, hydrocarbon decomposition reactions take place at medium and high pressures. These reactions are substantially identical with the corresponding radiation chemistry processes. In the case of n-heptane, the minimum temperature of the decomposition chain reaction was

~250°C. Above this temperature the average energy level of the system was large enough for the hydrocarbon radicals formed by radiations or by an electric field to produce a chain reaction by means of which radioinduced cracking is developed. In the case of paraffinic hydrocarbons the minimum temperature necessary for chain propagation was around 250°C. As a first approximation it was independent of whether the process was induced by ionizing (β or γ) or neutron radiation, or by an electric field, of which hydrocarbon was investigated, of liquid, mixed, or vapor phase, or method, and thus it can be considered a general characteristic value. The experiments are being continued to determine the material balances under various circumstances as well as the reaction kinetic characteristics. (auth)

514 KINETIC AND PREPARATIVE ASPECTS OF THE GAMMA-RADIATION-INDUCED REACTION BETWEEN PHOSPHORUS AND CARBON TETRACHLORIDE. A. Henglein and D. Perner (Hahn-Meitner Inst. of Nuclear Research, Berlin). p.427-30 of "Radiation Chemistry." Budapest, Publishing House of the Hungarian Academy of Sciences, 1964.

Radioinduced reactions between white phosphorus and carbon tetrachloride were studied. Red phosphorus was the main product at room temperature, while its yield was very low at high temperature. The high yields of PCl_3, CCl_3PCl_3, and of CCl_4 and the P-consumption showed that a chain reaction occurs at high temperature. The reaction was induced by free CCl_3 and Cl radicals resulting from radiolysis of the solvent. (M.C.G.)

515 CHEMICAL DOSIMETRY OF THE RADIATION CHEMICAL EFFECT OF THE SILENT ELECTRIC DISCHARGE. Z. Paál and G. Foeldiák (Hungarian Oil and Gas Research Inst., Budapest and Veszprém, Hungary). p.445-52 of "Radiation Chemistry." Budapest, Publishing House of the Hungarian Academy of Sciences, 1964.

It was concluded a silent electric discharge may be considered as a soft, high-intensity radiation totally absorbed by the system. The equivalent integral dose rate of the discharge was determined on the basis of chemical dosimetry. It was found that decomposition of nitrous oxide and methane can be used as chemical dosimeters to determine the equivalent integral dose rate of electric discharge. Up to the integral dose of about 2.10^8 gram-rad, the discharge chemical decomposition rate of methane was in first approximation independent of the voltage and was proportional only to the energy absorbed. An approximate integral dose rate of 10^7 to 10^8 rad/hr was available in the experimental electric discharge apparatus, which is chemically equivalent to a very large ^{60}Co radiation source. (auth)

516 ESR INVESTIGATION OF RADICAL INTERMEDIATES IN THE RADIOLYSIS OF SOME ORGANIC AND INORGANIC COMPOUNDS. V. A. Sharpaty (Karpov Inst. of Physics and Chemistry, Moscow). p.463-76 of "Radiation Chemistry." Budapest, Publishing House of the Hungarian Academy of Sciences, 1964.

On the basis of results obtained by investigation of the radiolysis of compounds of different types, ESR (electron spin resonance) techniques were found to be helpful in solving problems concerning the initial stage of radiolysis. It was also found helpful in investigating the problem of redistribution of absorbed radiation-energy between the components of the irradiated system. (auth)

517 STABILIZATION OF ORGANIC FLUIDS AGAINST RADIATION DECOMPOSITION AND SYSTEMS EMPLOYING SAME. James A. Ellard and William H. Yanko (to Monsanto Co.). U. S. Patent 3,152,961. Oct. 13, 1964. Filed Oct. 24, 1960.

It was found that rosin acids are stabilizers for polycyclic aromatic hydrocarbons subjected to radiation in their use as reactor coolant. Tall oil and distillation fractions of it were found to be very effective. A minimum addition of 2 wt % was preferred. The organic compounds can be polyphenyls, fused-ring hydrocarbons or mixtures thereof. When the compositions are subjected to radiation, decomposition products are formed, including gases and high boilers. It was found that in a reactor these high boilers can be tolerated up to about 30% in the fluid without a substantial decrease in heat transfer. (M.C.G.)

Radiochemistry

518 (IA-949) GAS CHROMATOGRAPHIC SEPARATION OF I^{131} PRODUCED BY NEUTRON IRRADIATION OF TELLURIUM COMPOUNDS. J. Tadmor (Israel. Atomic Energy Commission. Soreq Research Establishment, Rehovoth). May 1964. 16p. Dep.(mn).

The gas chromatographic separation of ^{131}I from various neutron-irradiated tellurium compounds was investigated. High recovery yields of carrier free ^{131}I, separated in a short time from minute amounts of neutron-irradiated tellurium compounds, were obtained. The repartition of ^{131}I activity in the different iodine compounds formed in the irradiated tellurium, was determined. (auth)

519 (TID-7696(p.53-63)) PAPER CHROMATOGRAPHY APPLIED TO RADIOLOGICAL CHEMISTRY. George A. Welford, Elias L. Chiotis, John S. Alercio, and Robert S. Morse (New York Operations Office. Health and Safety Lab., AEC).

Recent advances in paper chromatographic techniques are reviewed and applications in radiological chemistry are described. Apparatus and reagents used for the separation of fission products from solutions are discussed and procedures are outlined for the separation of Zr, Sr, Ba, Ce, Th, Ra, and U from urine. (C.H.)

520 THE PROJECTS AND WORK OF THE INSTITUTE FOR RADIOCHEMISTRY. W. Herr (Kernforschungsanlage, Julich, Ger.). Atompraxis, 10: 419-24(Sept.-Oct. 1964). (In German)

The Institute for Radiochemistry and the relatively wide scope of work planned for it are summarized. Data on some current investigations, chosen at random, are indicated. These include development of new radioanalytical measurement methods, radio gas chromatography, special problems of radiochemistry, and the study of homogeneous and heterogeneous exchange reactions. These offer new possibilities for the preparation of specifically labeled compounds. An additional research problem is concerned with the general chemistry of artificial radioelements. The properties of technetium that has unusual valence states in its compounds are under intensive study. (tr-auth)

521 MECHANISM OF BENZIDINE AND SEMIDINE REARRANGEMENTS. PART XII. KINETICS, PRODUCTS, AND ISOTOPE EFFECTS IN THE NON-CATALYTIC REARRANGEMENT OF 1,1'-HYDRAZONAPHTHALENE IN ETHANOL AND IN APROTIC SOLVENTS. D. V. Banthorpe and E. D. Hughes (Univ. of London). J. Chem. Soc., 2849-54(Sept. 1964).

2,2'-Dideuteration reduces the rate of decomposition of 1,1'-hydrazonaphthalene in neutral solvents, but 4,4'-dideuteration has not clearly been observed to do so. In aprotic solvents, no 4,4'-linked rearrangement products were formed, and the formation of 2,2'-linked products was strongly retarded by 2,2'-deuteration. In ethanol, both 4,4'-linked and 2,2'-linked products were formed, and the retardation of formation of the latter was as a consequence of 2,2'-dideuteration, much weaker. On the basis of these findings, some general comparisons were made between the mechanism of rearrangement as previously investigated under conditions of acid catalysis and the mechanism operating in the absence of catalysis in ethanol, and also in aprotic solvents. (auth)

522 TRITIUM EXCHANGE STUDIES ON POLY(ETHYLENE TEREPHTHALATE). Chul-yung Cha (Goodyear Tire and Rubber Co., Akron, Ohio). J. Polymer Sci., Pt. B, 2: 1069-73(Nov. 1964).

The tritium exchange technique was used to determine the alcoholic and carboxylic -OH groups. The results of end groups determination by tritium exchange and the status of the catalyst and stabilizer are reported. The presence of metal catalysts such as Zn and Sb in the polymer did not appear to influence the tritium exchange reactions. It was concluded that the metal of the catalyst does not appear to

be bound to the end groups. Therefore, the tritium exchange technique offers a sensitive method of determining the alcoholic and carboxylic -OH groups of poly(ethylene terephthalate). (P.C.H.)

523 MEASUREMENT OF THE SPECIFIC ACTIVITY OF TRITIATED WATER AND TRITIATED WATERY SOLUTIONS BY MEANS OF A HEATED IONIZATION CHAMBER. H. Langer (Institut fur Angewandte Radioaktivitat, Leipzig). Kerntechnik, 6: 404-7(Sept. 1964). (In German)

The development of a simple standard method for measuring the specific activity of tritiated water is described. In this method, a wide measuring range and sufficient insensitivity as concerns the purity of the substance is particularly emphasized. The problem of wall contamination and its elimination is dealt with. (auth)

524 A NEW METHOD FOR OBTAINING ELEMENTARY ^{35}S. C. Chiotan, I. Zamfir, and M. Szabo (Inst. for Atomic Physics, Bucharest). Rev. Roumaine Chim., 9: 191-4(Mar. 1964). (In French)

^{35}S is extracted by means of trichloroethylene from potassium chloride irradiated by slow neutrons, after heating to 500°. During the heating ^{35}S in the elementary state, formed at the interior of potassium chloride crystals, can migrate to the surface. The extraction yield is approximately 63%. In order to improve the extraction conditions, a small quantity of elementary sulfur can be added as carrier to the potassium chloride before irradiation. In this case, the extraction yield rises to 93%. (tr-auth)

525 A CELL FOR STUDYING VARIATIONS IN β EMISSION ACTIVITY IN VOLATILE MEDIA. V. A. Kachanov. Zavodsk. Lab., 30: 1147-8(1964). (In Russian)

The design is given of a cell for measuring liquid and gaseous β emitters using a teflon window. The activities of ^{14}C-labeled methyl iodide and benzene were measured. (R.V.J.)

Separation Processes and Procedures

Refer also to abstracts 760 and 919.

526 (EURAEC-1069) REPROCESSING OF IRRADIATED FUELS. Quarterly Report No. 16, January 1–March 31, 1964. (Centre d'Étude de l'Énergie Nucléaire, Mol, Belgium). Work Performed under United States–Euratom Joint Research and Development Program. Contract 098-62-11-RDB. 33p. (R-2289). Dep.(mn); $3.00 (cy), 1(mn) OTS.

Studies of the selective separation of U and Pu by ClF_3 confirmed the validity of the proposed method. Separation of the constituents was obtained for mixtures of sintered UO_2 having a 10% Pu content. Fluidized-bed research on the same reaction, but in the absence of Pu, revealed an important difference between the rate of the UF_4 reaction and that of the UO_2F_2 reaction; the latter rate is proportional to the ClF_3 concentration. Research on the UO_2–U_3O_8–UF_4 · UO_2F_2–UF_6 cycle is continuing. When UO_2 is sintered with 2% fissium, an appreciable decrease is observed in the oxidation rate by comparison with that of pure UO_2; however, an increase in the gas reactant concentration of 20 to 30% as well as in the temperature, from 450 to 525°C, enables an equivalent transformation rate to be obtained in both cases. The hydrofluorination and fluorination reactions on a 4-kg-U_3O_8-scale can be carried out continuously; they give a 99.5% UF_6 efficiency and a 60% F_2 efficiency (without recycling). The transfer of alumina after reaction takes place without difficulty. A newly installed UF_6 condenser is working satisfactorily. Studies were initiated on the decladding of fuel units. They depend on vibratory operations accompanied by heating the can in the presence of air. Development of the hot semi-pilot was continued. The absorption of UF_6 by molten salts, with a view to its transformation into UO_2, is favored by gas dispersion; an undried chloride bath also encourages this reaction. The possibility of regenerating a bath enriched in F ions under the action of HCl was demonstrated. (auth)

527 (HW-81746(p.4.5-11)) SOME ZEOLITE EQUILIBRIA WITH ALKALI METAL CATIONS. L. L. Ames, Jr. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). (HW-SA-3031)

Cation exchange equilibria for natural zeolites (erionite, clinoptilolite, and phillipsite) and the synthetic zeolites (Linde AW-300, AW-400, AW-500, 13X, 4A and Norton Zeolon) in the systems sodium–cesium, potassium–sodium, and potassium–cesium are presented, along with derived thermodynamic data. Gibbs free-energies and enthalpies for the various exchange reactions were relatively small. Reaction enthalpies diminished as the sizes of the two exchanging cations approached one another. Thermodynamic data proved to be useful in several cases for interpretation of zeolite equilibria but proved to be most valuable when used in correlation with other properties of the zeolite exchange systems. (auth)

528 (HW-81746(p.4.15-23)) SOME ZEOLITE EQUILIBRIA WITH ALKALINE EARTH METAL CATIONS. L. L. Ames, Jr. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). (HW-SA-3267)

Isotherms for the zeolites Linde Type A, natural erionite, phillipsite, and clinoptilolite in the systems sodium–strontium, sodium–calcium, and strontium–calcium are presented. Thermodynamic data derived from these isotherms indicated that reaction enthalpies are very small from 25 to 70°C. An inverse relationship was noted between SiO_2/Al_2O_3 ratios and divalent cation selectivities. The data, plotted as log Kc versus cation B on the zeolite, were adequately described by Barrer and Meier's case where $d\log Kc/dB_z$ does not equal a constant. (auth)

529 (HW-81746(p.4.72-3)) EFFICIENCY OF CHARCOAL FOR RADIOIODINE ABSORPTION. J. D. McCormack (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

The ^{131}I retention of charcoal deteriorates materially over a period of 60 days when used on a separations plant gaseous stream. Studies on the stream and laboratory studies using tracer ^{131}I showed: several organic constituents were present in the stream, hexone present didn't materially influence the elution of iodine, and methyl iodide at levels of 50 to 100 $\mu g/g$ of charcoal is rather easily eluted by passing air through the charcoal. The need for carefully evaluating the efficiency of charcoal under the conditions to be imposed was emphasized by these studies. (auth)

530 (HW-82400(p.4.1-4)) CHEMICAL PROCESSING OF NUCLEAR FUELS. M. T. Walling, Jr. and W. H. Swift (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

A survey is presented of chemical processing methods for reprocessing power reactor fuels. The decladding step is discussed in some detail, and the solvent extraction processes are considered. Reprocessing methods other than solvent extraction methods are discussed briefly. It is concluded that the reprocessing technology is well developed and will not present any obstacles to plutonium utilization. (D.L.C.)

531 (NAA-SR-9278) REPROCESSING OF URANIUM CARBIDE BY A NITRIDE–CARBIDE CYCLE. III. COMPLETE CYCLE AND FISSION PRODUCT STUDY. L. A. Hanson (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Oct. 15, 1964. Contract AT-11-1-GEN-8. 37p. Dep.; $2.00(cy), 1(mn) OTS.

A nitride–carbide cycle for reprocessing uranium carbide fuel has been investigated on a gram scale. The cycle consisted of three steps; nitride formation, nitride reconversion to carbide, and arc-melting. Nitride formation, carried out by reacting UC with nitrogen at 750 to 950°C, resulted in a pulverized mixture of uranium nitride and carbon. These mixtures were reconverted to carbide by heating in vacuum at 1300 to 2100°C. The extent of reconversion was found to be a function of temperature and carbon content. Suitable container materials for this process were molybdenum to 1700°C, tungsten or tungsten carbide to 2000°C, and graphite to 2100°C. Although samples heated above 1800°C in graphite gained in carbon content, excess

carbon was readily removed by hydrogen treatment. Arc-melting consolidated the re-converted carbide and lowered the residual nitrogen content. Fission product behavior was studied for each step of the nitride–carbide cycle. No decontamination occurred in the nitridation step. Over one-half of the rare earths and nearly all of the more volatile elements, cesium and strontium, were removed during the reconversion step. Arc-melting resulted in considerable additional fission product removal but also caused high plutonium losses. The overall cycle was effective in removing over three-fourths of the fission product activity. (auth)

532 (RT/CHI(64)-6) IMPIANTO PILOTA ESTRAZIONE EUREX. (Eurex Extraction Pilot Plant). M. Abita, D. Filoni, M. Fiorelli, A. Moccia, G. Proietti, and S. Cao (Italy. Comitato Nazionale per l'Energia Nucleare, Rome). May 1964. 131p. Dep.(mn).

Countercurrent equipment to be used in the Eurex plant was studied, developed, and tested in pilot plant operation. For criticality reasons, cylindrical shaped contactors were selected. A thorough pilot plant program to establish the experimental basis of the detailed design was set up in order to assess the influence of several variables on equipment efficiency and hydraulics. A detailed description of the pilot plant and of the experimental work carried out is given. (auth)

533 SEPARATION OF SCANDIUM FROM YTTRIUM, RARE EARTHS, THORIUM, ZIRCONIUM, URANIUM, AND OTHER ELEMENTS BY ANION EXCHANGE CHROMATOGRAPHY IN AMMONIUM SULFATE MEDIA. Hiroshi Hamaguchi, Atsuhiro Ohuchi, Tsuneo Shimizu, Naoki Onuma, and Rokuro Kuroda (Tokyo Kyoiku Univ.). Anal. Chem., 36: 2304-6(Nov. 1964).

Sc(III) is adsorbed on a strongly basic anion exchange resin, Dowex 1, X-8 (sulfate form), from 0.1M $(NH_4)_2-SO_4-0.025M$ H_2SO_4 solution. Under these conditions Y(III), rare earths(III), Al(III), Be(II), Cd(II), Co(II), Cu(II), Ga(III), Ge(IV), Mg(II), Mn(II), Ni(II), V(IV), and Zn(II) are not adsorbed to any great extent, while Mo(VI), Ta(V), Th(IV), Zr(IV), and U(VI) are strongly retained by the exchanger. Sc(III) can be quantitatively separated from macroamounts of any of the cations above. An anion exchange chromatographic procedure for the separation of the rare earths(III), Sc(III), Th(IV), Zr(IV), and U(VI) was also developed, where all five of the metallic ions can be chromatographically separated by a consecutive elution with $(NH_4)_2SO_4$, HCl, and $HClO_4$. (auth)

534 CATION EXCHANGE SEPARATION OF TITANIUM AND ZIRCONIUM USING PERCHLORIC ACID. APPLICATION TO THE ANALYSIS OF PZT CERAMICS. R. G. Dosch and F. J. Conrad (Sandia Lab., Albuquerque, N. Mex.). Anal. Chem., 36: 2306-8(Nov. 1964).

A description is given of a cation exchange procedure for a quantitative separation of zirconium and titanium from lead and bismuth, and from each other, using $HClO_4-NH_4F$ mixtures and $HClO_4$ as eluents. The procedure was applied to the analysis of high-fired lead oxide–zirconium oxide–titanium oxide ceramic material (PZT). (auth)

535 SEPARATION OF AMERICIUM FROM CURIUM WITH CALCIUM FLUORIDE. H. Perry Holcomb (E. I. du Pont de Nemours and Co., Aiken, S. C.). Anal. Chem., 36: 2329-32(Nov. 1964).

Americium(VI) was separated from curium(III) and other trivalent actinides and lanthanides with a column of calcium fluoride. Americium(VI) is soluble in fluoride solutions and passes through the column; curium(III) and other trivalent actinides and lanthanides are not soluble and are retained. The separated americium is determined by alpha pulse height analysis. Americium recovery averaged 102% for process samples in which curium alpha activity was 600 times that of americium. An internal standard, ^{241}Am, was used to correct for yield in the analysis of these samples that contained 283 μg ^{243}Am per milliliter. The curium activity of the samples was reduced at least by a factor of 10^5 to 10^6. The relative standard deviation was 1.9% (n = 6). (auth)

536 EUROPEAN PLANT FOR PROCESSING IRRADIATED FUEL ELEMENTS AT MOL (BELGIUM). [PART] II. T. J. Barendregt. Atoomenergie Haar Toepassingen, 6: 175-82(Sept. 1964). (In Dutch)

A concise review is given of the design of the process building and the chemical process to be used in the processing of irradiated fuel elements. A brief indication is presented of the program for the coming year. (J.S.R.)

537 EXTRACTION OF STRONTIUM AND CERIUM COMPLEXES WITH DI-(2-ETHYLHEXYL) PHOSPHORIC ACID BY ORGANIC SOLVENTS. Z. Kolarik and H. Pankova (Inst. for Nuclear Research, Czechoslovak Academy of Sciences, Rez). Collection Czech. Chem. Commun., 29: 2023-9(Sept. 1964). (In German)

The pH dependence of the strontium and cerium extraction with solutions of di-(2-ethylhexyl) phosphoric acid in n-hexane was investigated. The composition of the complexes extracted was determined. (tr-auth)

538 THE RAPID ROUTINE SEPARATION AND ANALYSIS OF ^{14}CO AND $^{14}CO_2$ IN MIXTURES OF LOW ACTIVITY. F. S. Feates (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Sci. Instr., 41: 641-2(Oct. 1964).

A simple apparatus is described in which ^{14}CO and $^{14}CO_2$ can be separated and the specific activity of the components rapidly measured. The method can be applied to very small quantities of gas (1 μM) or samples of low activity (50 disintegrations per minute) with 1% reproducibility. (auth)

539 SORPTION OF THE RADIOISOTOPES ON SOME IONITES. Zbigniew Smal, Jan Bulanda, Jozef Horski, and Aleksander Siemaszko (Inst. of Nuclear Research, Warsaw) Nukleonika, 9: 733-44(1964). (In Polish)

Decontamination of natural waters contaminated with radioisotopes was investigated as well as the influence of the velocity of throughpass in columns on sorption. Ion exchange materials used were polish cationites MK-2 (or MK-3), Escarbo, and Russian anionite EDE-10-P. The decontaminated water is salt free and cannot be used for communal purposes. (auth)

540 PARTITION CHROMATOGRAPHY OF RARE EARTH AND TRANSURANIUM ELEMENTS IN THE SYSTEM TBHP–TBPP/NITRIC ACID. J. Mikulski, K. A. Gawrilow, and V. Knobloch. Nukleonika, 9: 785-94(1964). (In Russian)

The extractive properties of the rare earth (Pm, Eu, Tb, Tm) and transuranium (Am, Cm, Cf, Fm, Md) elements were studied in the system TBHP–TBPP/HNO_3 using the method of partition chromatography. The separation coefficients of neighboring rare earth elements are practically constant, amounting to 1.34. For Am and Cm the separation coefficient is 1.25 whereas for the heavier transuranium elements the coefficient is only 1.05. (auth)

541 DISTRIBUTION OF THE ALKALI HALIDES BETWEEN THE AQUEOUS AND THE ORGANIC SOLUTIONS OF IODINE. PART I. DISTRIBUTION OF THE IODIDES OF CESIUM AND OF CERTAIN OTHER ALKALI METALS BETWEEN AQUEOUS AND ORGANIC SOLUTIONS OF IODINE. V. M. Vdovenko and L. S. Bulyanitsa. Radiokhimiya, 6: 385-98(1964). (In Russian)

In order to determine the optimum conditions for the extraction of Cs, the dependence of the distribution of CsI between the organic and aqueous phases on the properties of the organic solvent was investigated. The factors examined included the partition coefficient α_{CsI} as a function of the salt concentration, electric conductivity, and solubility. Organic solvents with widely differing dielectric constants and basicity were used for the study, including nitromethane, nitrobenzene, n-amyl alcohol, iso-amyl acetate, diethyl ether, and dibutyl ether. It was found that the distribution isotherm may be derived from one of 2 equations or from their linear combination. In all cases, lowering of the isotherm agreed well with the decrease of activity of iodine in the extracting agent. The distribution of CsI between the aqueous solution and solutions of I_2 in nitromethane nitrobenzene and of NH_4I between the aqueous

solution and the solution of I_2 in nitrobenzene, the constants of complex formation φ of the $I_3^- + I_2 \rightleftharpoons I_5^-$ reaction were determined as follows: $\varphi_{CsI} = 32.5$ for nitromethane; $\varphi_{CsI} = 375$ for nitrobenzene; $\varphi_{NH_4I} = 200$ for nitrobenzene. Electrical conductivity measurements of 0.05M solutions of I_2 in nitrobenzene, n-amyl acetate, diethyl ether, and dibutyl ether revealed that in the first solvent the CsI_{2n+1} is almost completely dissolved; the electrolytic dissociation constant R_{CsI} in the other solutions was found to be 10^{-11} in the dibutyl ether and $3.5 \cdot 10^{-6}$ in amyl acetate. (TTT)

542 DISTRIBUTION OF THE ALKALI HALIDES BETWEEN THE AQUEOUS AND THE ORGANIC SOLUTIONS OF IODINE. PART II. DISTRIBUTION OF CESIUM IODIDE BETWEEN AQUEOUS SOLUTIONS AND SOLUTIONS OF IODINE IN TRIBUTYL PHOSPHATE. V. M. Vdovenko and L. S. Bulyanitsa. Radiokhimiya, 6: 399-411(1964). (In Russian)

Tributyl phosphate (TBP) and its solutions in n-octane were used as solvents for determining the mechanism of the distribution of alkali polyiodides between the aqueous and organic phases. The study included conductivity measurements of I_2 solutions in TBP at 25 ± 0.1°C, determination of the dielectric penetrability of TBP–n–octane mixtures at 10^6 cyles/sec, measurement of oxidation-reduction potentials with Pt and saturated calomel electrodes, together with measurement of the absorption spectra of the organic solutions of CsI and I_2. Equilibrium in the distribution of CsI between the aqueous and organic phases was reached by stirring the solutions together and separating by centrifugation. Establishment of the equilibrium was determined on the basis of the constancy of the dissociation coefficient α_{CsI}; during these measurements the pH was kept near 5. Reversibility of the system was verified by reverse distribution studies, dissolving the crystalline CsI in the organic phase and introducing the radioactive indicator into the organic solution at a very low concentration. As a result of these measurements, the value of the partition constant $\overline{K}$ at a given I_2 concentration in the extracting agent was determined within a very wide CsI and I_2 concentration range. The value of $\overline{K}$ was found to be affected by equilibrium in the I_2–TBP system, degree of electrolytic dissociation in the organic phase, reduction of the effective TBP concentration, polymerization of the organic phase, and changes in the dielectric penetrability of the solution. (TTT)

543 EXTRACTION OF COMPLEX ACIDS BY OXYGEN-CONTAINING SOLVENTS. PART III. STUDY OF THE EXTRACTION OF TRIVALENT ANTIMONY. B. Z. Iofa and G. M. Dakar. Radiokhimiya, 6: 411-19 (1964). (In Russian)

The extraction of micro- and macroamounts of Sb(III) by oxygen-containing compounds from aqueous solutions of $LiNO_3$ and LiCl with HCl and from neutral solutions of LiCl was investigated using the ^{125}Sb isotope. The state of Sb(III) was examined spectrophotometrically in the organic and aqueous phases. Benzyl acetate, n-hexyl alcohol, iso-amyl alcohol, and ethyl acetate were used as extracting agents. It was found that in the concentration range from 10^{-3} to 5×10^{-3} M of Sb(III), the partition coefficients are independent of concentration, indicating that Sb does not poiymerize in either the organic or the aqueous phase. Differences in results with benzyl acetate in comparison with earlier studies, were attributed to the formation of complex esters formed during extended contact of the organic compound with HCl solutions in the previous investigation. Results indicated that the extraction process of the Sb(III) follows a hydrate-solvate type mechanism. In solutions containing Li, complex formation stops at the $SbCl_4^-$ level and not at the $SbCl_5^{--}$ complex, which is formed only in acid solutions. The appearance of maxima in the extraction curves is due to the presence of trivalent Sb in the organic phase. (TTT)

544 EXTRACTION OF COMPLEX ACIDS BY OXYGEN-CONTAINING SOLVENTS. IV. EXTRACTION OF TETRAVALENT TIN. B. Z. Iofa, K. P. Mitrofanov, M. V. Plotnikova, S. Kopach. Radiokhimiya, 6: 419-25 (1964). (In Russian)

Although distribution coefficients (d.c.) were determined for Sn(IV) between HCl solutions and oxygen-containing solvents, there is little published work on the mechanism. Therefore equilibrium d.c.'s were determined for Sn(IV) between HCl solutions and ketones, alcohols, and simple and complex esters, by use of ^{123m}Sn and ^{113}Sn tracer. The extracted compounds were examined by ultraviolet absorption spectrum and Mössbauer effect measurements. The results indicated a hydrate-solvate mechanism from high and moderate HCl concentrations, but from weak acid solutions apparently the salt $[SnCl_4(H_2O)_2] \cdot (org)_\gamma$ was extracted. Tabulated data and a graph are presented, which show poor extraction by simple esters from all concentrations of HCl, moderate extraction by a ketone, and good extraction only by alcohols. The absorption maximums for solutions of Sn(IV) in 2 to 10M HCl were the same as for the n-octyl alcohol extracts from these solutions, indicating that the tin is in the same form in the organic as in the aqueous solution. For the Mössbauer studies $^{119m}SnO_2$ was used as the source. Resonance absorption spectrums of Sn(IV) in 10M HCl, the extract from it by n-octyl alcohol and dipropyl ketone, and the corresponding aqueous residues had maximums at +0.50 mm/sec, as did $(NH_4)_2SnCl_6$ in the form of $SnCl_6^{--}$ ions. (TTT))

545 ASSOCIATION OF ORGANOPHOSPHORUS DERIVATIVES WITH CHLOROFORM AND THE EFFECT OF THE NATURE OF THE DILUENT ON SALT EXTRACTION. M. F. Pushlenkov and E. V. Komarov. Radiokhimiya, 6: 426-33(1964). (In Russian)

In studies on the effect of the type of diluent on tributyl phosphate (TBP) extraction properties, attempts were made to correlate the distribution coefficient of the metal with diluent properties. The spectrums of TBP, dibutyl ester of dibutylphosphonic acid (DBEBP), butyl ester of dibutylphosphinic acid (BEDBP), and tributylphosphinic oxide (TBPO) were measured. To avoid the overlapping of the absorption band of the C–H bond in chloroform with that of the butyl radical, deuterated chloroform was used as diluent. The data showed that chloroform forms an associate with organophosphorus derivatives through the H bond. This is considered to play a decisive role in decreasing the distribution coefficient of uranyl nitrate when chloroform is used as the diluent instead of CCl_4. When the phosphorus compounds were added to a solution of $DCCl_3$ in CCl_4, regardless of the P compound concentration, the maximums in the spectrums were displaced toward the lower wave numbers. The structure of the associated complex is written as $\equiv PO \ldots DCCl_3$. The intensity of the displaced bands increased sharply. (TTT)

546 EFFECT OF THE MAGNITUDE OF ION CHARGES ON EXTRACTION. II. CONCENTRATED AND DISPERSED CHARGES. V. I. Kuznetsov and L. I. Moseev. Radiokhimiya, 6: 433-9(1964). (In Russian)

Since the state of the extracted compound affects the extraction, singly charged anions are best for extracted singly charged cations, doubly charged anions for doubly charged cations, etc. In studies on this effect, concentrated charged ions studied were dipositive pyridine complexes of zinc and cadmium and dinegative dimethylaminobenzene and (1-phenyl-azo)2-oxy-naphthalene arsono acids; dispersed were dipositive benzidine and p-phenylenediamine ions and dinegative phenylazooxynaphthalene sulfo acids. The data showed that salts formed by doubly charged ions with concentrated charges were completely extracted by chloroform and isobutanol from aqueous solution at pH 7.5. Salts that could be formed from the doubly charged ions used with dispersed charges were not extracted in the pH range 2 to 10. The two charges of the arsono group were considered as concentrated and the two charges of the two sulfo groups when in the ortho position were considered "partially concentrated." Sulfo groups located farther apart were considered dispersed charges. The azo compound with both an arsono group and a sulfo formed a triply charged anion in which two charges were concentrated and the third was not. This anion was completely extracted with a mixture of singly (Ag) and doubly (Zn) charged cation pyridinates. (TTT)

547 EXTRACTION OF TECHNETIUM BY PHOSPHORIC ACID DERIVATIVES AND TRIOCTYL AMINE FROM NITRIC ACID SOLUTIONS. A. A. Zaitsev, I. A. Lebedev, S. V. Pirozhkov, and G. N. Yakovlev. Radiokhimiya, 6: 440-4(1964). (In Russian)

Data were obtained on the extraction of Tc(VII) from nitric acid solutions by several organophosphorus compounds; 6-hr ^{99m}Tc was used as the tracer. Extraction was good by neutral extractants but not by acid ones. From aqueous nitric acid solutions of 0.1 to 4M concentration, the extraction decreased sharply with dilution of the extractant with an inert solvent. The distribution coefficient with 0.2M trioctylphosphinic oxide (TOPO) was dependent on the nitric acid concentration in the aqueous phase, and was maximum at 0.1N nitric acid. However, it was also high at 12M, where the technetium appeared to be extracted as a cation. This was also observed with tributyl phosphate (TBP) and with diisoamyl ester of methylphosphonic acid (DAMP). However, although the TBP and DAMP dependences were similar, the absolute value of the distribution coefficient was significantly higher with DAMP, especially from weak acid solutions. Both extracted technetium from neutral and alkaline was well as acid solutions. Extraction was directly linearly dependent on the extractant concentration (logarithmic graphs) in the case of TBP and DAMP. With nitric acid and sodium nitrate solutions the hydrogen ion concentration did not affect the extraction. Re-extraction of the technetium from 50% DAMP and from 0.5M TOPO was feasible with ammonium hydroxide. However, re-extraction from TBP was difficult, which limits the use of this extractant. (TTT)

548 EXTRACTION OF TECHNETIUM(VII) BY PYRIDINE DERIVATIVES FROM ALKALINE SOLUTIONS. A. A. Zaitsev, N. A. Lebedev, S. V. Pirozhkov, and G. N. Yakovlev. Radiokhimiya, 6: 445-8(1964). (In Russian)

The extraction of Tc(VII) from alkaline solutions by pyridine derivatives was studied with the 6-hr isotope ^{99m}Tc used as a tracer. The four pyridine homologs tested were significantly better extractants than pyridine. The heavy pyridine bases had an advantage in being soluble in water. The extraction as a function of alkali concentration showed a sharp increase at about 3M sodium hydroxide. Addition of small quantities of sodium nitrate sharply lowered the distribution coefficient, but further increase in the nitrate concentration had far less effect. However, even with this decrease by nitrate, lutidine and aldehydin extracted technetium completely from 2.9M sodium nitrate–0.1M sodium hydroxide solutions. The presence of alkali metallic ions affected the technetium extraction in the decreasing order lithium–sodium–potassium–ammonium–rubidium–cesium; i.e., as the cation hydration energy decreased, the effect decreased. Extraction of other traced fission products (^{95}Zr–^{95}Nb, ^{106}Ru, ^{147}Pm, ^{99}Mc, and ^{137}Cs) showed that high-purity technetium can be obtained by one extraction with aldehydin; lutidine also gave good technetium separation. For separating technetium from pyridine and lutidine, the organic compound may be steam distilled, or the technetium may be re-extracted after dilution of the organic with an inert diluent. (TTT)

549 PROCESSES AND PRODUCTS OF HIGH-MOLECULAR COMPOUNDS WITH INORGANIC SALTS. PART IV. THE REACTIONS OF POLYACROLEIN WITH TANNIN AND GELATIN IN SALT SOLUTIONS. I. V. Andreeva, G. O. Keshishyan, P. F. Andreev, and L. T. Danilov. Radiokhimiya, 6: 491-3(1964). (In Russian)

It was found previously that at specific pH values tannin, gelatin, and certain other organic compounds form insoluble precipitates with polyacrolein; these precipitates possess a large specific surface. It was assumed that such high-surface compounds, provided with active complex-forming groups could be used for the removal of ions from solutions. Experiments indicated that polyvinyl alcohol also may be precipitated by tannin, although not by gelatin. It was found that the polyacrolein tannate system carry with it dissolved U salts; within the pH range from 3 to 7, U may be thus completely removed from the solution. In the presence of the compound Trilon B, the tannin–polyacrolein complex was able to separate the U from a 200 fold excess of Fe. If the solution also contained Ra, about 85% of it remained in the solution. The PVA–tannin and the polyacrolein–gelatin complexes were also found to be excellent precipitating agents for the removal of U from its aqueous solutions. (TTT)

550 STUDY OF THE COMPLEX FORMATION IN NONAQUEOUS SOLUTIONS. PART VI. DETERMINATION OF THE LEVEL OF SOLVATION BY THE POLYTHERM METHOD. A. A. Chaikhorskii. Radiokhimiya, 6: 494-6 (1964). (In Russian)

The level of solvation of a material to be extracted from an organic phase may be determined by a temperature difference method, which has the advantage over the currently employed methods, such as the absorption or cryoscopic methods, that it may be applied without the use of inert diluents. The graphical method, involving determination of three experimental points, derived from equations involving the partition coefficient, allows the level of solvation in the organic phase to be determined from the slope of a straight line. The activity of the bound molecules must be known in one of the phases; the activity of the organic solvent is obtained from its vapor pressure. The method cannot be used if competing secondary reactions take place in the organic phase. (TTT)

551 SEPARATION OF ^{117m}Sn AND ^{111}In CARRIER-FREE FROM A CYCLOTRON TARGET. I. M. Rozman, Yu. A. Ryukhin, and A. F. Chachakov. Radiokhimiya, 6: 500-2 (1964). (In Russian)

The previously used distillation method for separating Sn and In isotopes from a Cd target presents many disadvantages; therefore, an ion-exchange method was developed. The 150-μ-thick Cd foil was rolled on a water-cooled Cu support and was exposed to 21-Mev α particles in the cyclotron at a current of 5 to 8 μa for a total of 295 μa. After irradiation, the foil was dissolved in 13M HNO_3, $FeCl_3$ added to the solution, and $Fe(OH)_3$ precipitated with NH_4OH. After 3 reprecipitation operations, the $Fe(OH)_3$ was found to contain 92. ± 5% of the Sn and 90 ± 5% of the In. The precipitate was dissolved in HCl and the solution was passed through an ion-exchange column filled with 200-mesh grain-size Dowex 1 × 8 resin. The In was eluted with 10.5M HCl, the Fe with 0.1M oxalic acid and the Sn with 2M $HClO_4$. The chemical yield was 90 ± 5% for In and 85 ± 5% for Sn. The operation was carried out in 2 to 3 hours. During irradiation by α particles, the following long-lived In and Sn isotopes were formed in the Cd target: ^{111}In(2.84 days), ^{114m}In(49 days), ^{113}Sn(130 days), ^{117m}Sn(14 days), and ^{119m}Sn(250 days). The In was determined on the basis of the 247-kev of ^{111}In and the Sn by the 393-kev line of ^{113m}In, a Sn daughter, by γ spectrometry. The separation method was also used for studying the ^{116}Cd(α,n)^{117m}Sn reaction. (TTT)

552 INVESTIGATION OF THIOCYANATE COMPLEXES OF ZIRCONIUM IN A PERCHLORATE MEDIUM BY THE EXTRACTION METHOD. I. V. Vinarov, A. I. Orlova, G. I. Byk, and N. F. Kislitsa (Inst. of General and Inorganic Chemistry, Academy of Sciences, Ukrainian SSR). Ukr. Khim. Zh., 30: 758-61(1964). (In Russian)

Solvent extraction of zirconium from perchloric acid using acetophenone was studied, and the zirconium distribution coefficient was determined. Experimental data indicate that during the extraction various complex zirconium ions, among them $[Zr(SCN)_2]^{2+}$ and $[Zr(SCN)_4]$, moved from the aqueous into the organic phase. Extraction of isomolar zirconium thiocyanates by acetophenone was not efficient. The highest extraction was achieved with complex $[Zr(SCN)_6]^{2-}$. (R.V.J.)

553 AN APPARATUS FOR SEPARATING GASES BY GAS DIFFUSION THE MOLECULAR WEIGHTS OF THE GASES BEING ONLY LITTLE DIFFERENT. Georges Bouligand and Pierre Delarousse (to Commissariat à l'Energie Atomique). German Patent 1,167,797. Apr. 16, 1964. Priority date May 4, 1957, France).

The multistage apparatus uses cells with a high-pressure section and a low-pressure section separated by a porous

partition, a mixture supply line to the high-pressure section, an outlet line for the mixture enriched in the lighter component at the low-pressure section, and an outlet line for the mixture depleted in the lighter component at the high-pressure section. Each stage consists of two cells. The outlet line of the low-pressure part of the first cell of each stage is connected to the mixture supply line of the first cell of the succeeding stage. The outlet line of the low-pressure section of the second cell of each stage is connected to the mixture supply line of the first cell of the same stage. The outlet line of the high-pressure section of the first cell is connected to the mixture supply line of the second cell of the same stage. In order to enable the number of stages to be considerably decreased the outlet line of the high-pressure part of the second cell of each stage is connected to the mixture supply line of the second cell of the preceding stage. (Gmelin Inst.)

554 PROCESS FOR TREATING URANIUM-CONTAINING OXIDE ORES. Oscar A. Fischer. U. S. Patent 3,152,862. Oct. 13, 1964. Filed Nov. 23, 1960.

A roasting process was developed for treating uranium-containing pitchblende ores to obtain a water-soluble uranium sulfate. The amount of sulfur-bearing compound used in the conversion is proportional to the quantity of sulfate to be formed and to the heat input. A charge of pitchblende ore is passed as a moving bed through at least two heating stages along a confined course under gradually increasing temperatures. The charge contains sufficient anhydrous metallic sulfide to act as a catalyzer during decomposition of the sulfide content. (M.C.G.)

ENGINEERING

General

Refer also to abstract 1089.

555 (ACNP-64028) STEAM SEPARATION TECHNOLOGY UNDER THE EURATOM PROGRAM. Quarterly Progress Report, July 1–September 30, 1964. (Allis-Chalmers Mfg. Co. Atomic Energy Div., Milwaukee). Oct. 10, 1964. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(11-1)-1186. 63p. (EURAEC-1220). Dep.(mn); $3.00(cy), 2(mn) OTS.

The construction of the large upcomer test loop in the air-water tank was completed and testing of the separator in the high flow range gives good results. A test loop for the horizontal separator was constructed. Preliminary test results show the separator will form a vortex and will separate in the horizontal position. Tests of a 360-degree radial arc separator were run above a simulated core in the air-water tank. These tests were run with and without a separator to determine the efficiency of the separator. The 360-degree hooded crossover was installed in the steam-water test facility. Initial test results substantiate the good performance characteristics predicted in the air-water tests. Work on carryunder in a natural circulation system was completed and an equation for predicting the downcomer void fraction in terms of loop conditions and dimensions was put in final form. Testing of the chevron type dryer was continued in the steam-water facility. Due to mechanical difficulties with the calorimeter and associated instruments, the test was suspended temporarily and the hooded crossover test was begun. (auth)

556 (IITRI-528-19) PLASTIC INSTABILITY OF CYLINDRICAL SHELLS WITH RIGID END CLOSURES. M. A. Salmon (Illinois Inst. of Tech., Chicago. IIT Research Inst.). [1962]. Contract AT(11-1)-528. 102p. Dep.; $4.00 (cy), 2(mn) OTS.

Solutions are obtained for the large plastic deformations of a cylindrical membrane with rigid end closures subjected to an internal pressure loading. A plastic-linearly hardening material obeying Tresca's yield criterion and the associated flow rule is considered. It is found that, in general, a shell passes through three stages of deformation finally assuming a spherical shape. The instability pressure (maximum pressure) may be reached in any of the stages depending on the length/diameter ratio of the shell and the hardening modulus of the material. While numerical integration is required to obtain solutions for shells in the first two stages of deformation, the solution in the final stage is given in closed form. A comparison of the predictions of the theory with the results of a single test conducted at the Naval Ordnance Laboratory is made. For the purpose of comparison exact solutions are also obtained in a few cases for a material obeying the Mises yield criterion. (auth)

557 (SC-DC-64-1509) A STUDY OF IMPACT EFFECTS ON SPHERICAL SHELLS. Quarterly Progress Report No. 3, May 1–July 1, 1964. Charles E. Stoneking (Georgia Inst. of Tech., Atlanta. Engineering Experiment Station). For Sandia Corp., Albuquerque, N. Mex. Contract [AT(29-1)-789]. 21p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The development and construction of the equipment and facility for studying the structural integrity of hollow spheres when they are impacted against a rigid target of known properties are discussed. The pressure bar technique developed by Hopkinson is to be used to measure impact pressure. Present analysis attempts to determine the critical rupture velocity for a homogeneous isotropic cylindrical shell of finite length having closed ends. The material used to construct the shell will be assumed to have a stress-strain relation independent of the loading rate. (N.W.R.)

558 (SC-RR-64-530) CONTAINMENT CAPSULE IMPACT SAFETY STUDY SPECIAL REPORT ON END-CAP INVESTIGATION. C. W. Young (Sandia Lab., Albuquerque, N. Mex.). Aug. 1964. Contract AT(29-1)-789. 30p. Dep.(mn); $2.00(cy), 1(mn) OTS.

A series of impact tests was conducted to determine an end cap design suitable for use in the Containment Capsule Impact Safety Study (CCISS). It was found necessary to increase the shear strength of the end cap material and to determine a more suitable geometric design than that suggested in the original proposal. (auth)

559 (TID-4100(Suppl.24)) SUPPLEMENTAL INSERT SHEETS FOR ENGINEERING MATERIALS LIST. Supplement 24. Richard E. C. Duthie, ed. (Division of Technical Information Extension, AEC). Oct. 1964. 46p. Dep.; Free(DTI Extension).

Included are lists under computers, engineering equipment, hot laboratory equipment, instruments, metallurgical equipment and processes, nuclear radiation instruments, particle accelerators, and radiation equipment (biological). (D.L.C.)

560 (TID-18555) ADHESIVE BONDING—ADVANTAGES AND APPLICATION PROCEDURES. N. J. De Lollis (Sandia Corp., Albuquerque, N. Mex.). [Apr. 1963]. Contract AT(29-1)-789. 12p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Adhesives fill a requirement in the fastening of thin gage materials in that they utilize to the full the strengths of the materials bonded. A description is given of the reasons for using adhesives and the procedures necessary to achieve satisfactory bonds. Emphasis is placed on the use of proper procedures in proper sequence. (auth)

561 (UCRL-7964) SURVEY OF SHOCK DAMAGE TO SURFACE FACILITIES AND DRILLED HOLES RESULTING FROM UNDERGROUND NUCLEAR DETONATIONS. Lewis J. Cauthen, Jr. (California. Univ., Livermore. Lawrence Radiation Lab.). July 1964. Contract W-7405-eng-48. 33p. Dep.; $2.00(cy), 1(mn) OTS.

Damage to construction and support facilities required to execute underground nuclear detonations has been summarized. The effect of explosion-included ground motion on residential-type buildings has been consolidated and extended to effects of underground nuclear explosions. No damage has been suffered by prefabricated steel buildings subjected to ground motions as high as 5 g acceleration, and 150 cm/sec velocity. Newly built residential models have survived without damage peak surface velocities of approximately 20 cm/sec, whereas industrial experience has been that minor cracking of plaster in average homes might be expected at peak velocities of 11 cm/sec. Securely tying machinery to the ground appears to significantly reduce damage. Generators anchored to machinery foundations have survived peak surface velocities of greater than 100 cm/sec, while similar equipment merely resting on the ground has been moderately damaged by less severe motion (50–100 cm/sec). Various damage levels for other facilities are tabulated. (auth)

562 (VUF-1016) PROJECT SHOAL—TEST OF DRIBBLE-TYPE STRUCTURES. (Holmes and Narver, Inc., Las Vegas, Nev.). Jan. 1964. Contract AT(29-2)-20. 40p. Dep.; $2.00(cy), 1(mn) OTS.

Observations were made on the response of simulated Dribble area building foundations to ground motion induced by a nuclear detonation. The effectiveness of bracing methods was tested. The results found were: Peak particle velocities of from 15 to 20 cm/sec (6 to 8 inches per second) and peak accelerations of up to 1.3 g did not cause lateral collapse of the unbraced pier foundations. Such motions did crack the more heavily loaded interior pier blocks. Timber bracing cribs, such as those prescribed in the H&N Preshot Damage Report for Dribble, were effec-

tive in reducing pier damage. Damage was not, however, completely prevented by the cribs. No damage to unbraced buildings resulted from peak particle velocities of 9.6 cm/sec (3.8 inches per second) and peak accelerations of 0.75 g. Peak motions of this magnitude will probably occur as far as 1.6 miles from the Dribble Salmon SZ, and possibly as far as 2.4 miles from SZ. Recommendations are given for bracing foundations of residences in the Dribble area. (D.L.C.)

Applications of Nuclear Explosions

Refer also to abstract 608.

563 (PNE-240-F) GEOLOGIC STUDY OF THE SEDAN NUCLEAR CRATER. William D. Richards (California. Univ., Mercury, Nev. Lawrence Radiation Lab.). June 1964. Project SEDAN. Contract W-7405-eng-48. 44p. Dep.; $2.00 (OTS).

The 100-kt nuclear experiment, Sedan, resulted in a symmetrical, bowl-shaped crater having an apparent volume of 6,550,000 cubic yards, a diameter of 1220 ft, a depth of 323 ft, and an average lip height of 42 ft. The lip varies in height from 14 to 99 ft and consists mainly of permanently uplifted alluvium and overturned alluvium. Fallback accounts for only a few feet of the total lip thickness. The permanently uplifted alluvium exposed in the crater shell is remarkably consistent in elevation and continuity. The rubble-like debris below the crater bottom and above the detonation point probably collapsed as a unit with the alluvial material maintaining its original stratigraphic order. Only minor amounts of radioactive material were encountered in this zone. Temperature and density variations also exist in this collapse debris. (auth)

Facilities and Equipment

Refer also to abstracts 536, 1515, 1825, 1890.

564 (BAW-1280-14) SODIUM-HEATED STEAM GENERATOR DEVELOPMENT. Progress Report No. 14, June 1964. (Babcock and Wilcox Co., Barberton, Ohio). Contract AT(11-1)-1280. 58p. Dep.(mn); $3.00(cy), 1(mn), OTS.

The preliminary design of the full-size steam generator is complete. Preliminary design of the prototype is in progress. The design work under Phase I is 82% complete. (auth)

565 (BAW-1280-15) SODIUM-HEATED STEAM GENERATOR DEVELOPMENT. Progress Report, July 1964. (Babcock and Wilcox Co., Barberton, Ohio). Contract AT(11-1)-1280. 54p. Dep.(mn); $3.00(cy), 2(mn) OTS.

The preliminary design of the full-size steam generator is complete. Preliminary design of the prototype is in progress. The design work under Phase I is 89% complete. (auth)

566 (BAW-1280-16) SODIUM-HEATED STEAM GENERATOR DEVELOPMENT. Progress Report, August 1964. (Babcock and Wilcox Co., Barberton, Ohio). Contract AT(11-1)-1280. 52p. Dep.(mn); $3.00(cy), 1(mn) OTS.

The preliminary design of the full-size steam generator is complete. The preliminary design of the prototype steam generator is in progress. The design work under Phase I is 94% complete. (auth)

567 (LA-3109) THE DEVELOPMENT OF A DRY INERT ATMOSPHERE DRYBOX SYSTEM. Al. Zerwekh, William H. Ashley, and Charles F. Metz (Los Alamos Scientific Lab., N. Mex.). Apr. 1964. Contract W-7405 eng-36. 34p. Dep.; $2.00(cy), 1(mn) OTS.

A dry, inert atmosphere drybox system has been designed and assembled. The system was put in operation approximately 1 year ago, and so far it has been completely satisfactory. This system maintains a working atmosphere of argon containing less than 20 parts per million each of oxygen and water. There is no provision for the removal of nitrogen or other residual components of air, with the exception of carbon dioxide. It is instrumented with a Beckman Model 80 Oxygen Trace Analyzer and a Beckman Hygromite portable electrolytic hygrometer. The system consists of three stainless steel dryboxes, each isolated from the balance of the system by "absolute" submicron filters. Each box is fitted with butyl rubber gloves and specially designed neoprene glove port covers for maximum protection against water and oxygen diffusion into the system. The recirculated argon atmosphere is purified by uranium turnings heated to 700°C, a Zeolite Lectrodryer column, and an Ascarite canister. Entrance to either end of the system, or communication between individual boxes, is effected through cylindrical airlocks and ports. A subsystem of pressure-activated switches and solenoid valves maintains the boxes at a slight positive pressure. Molten sodium samples in the system remain bright for periods up to 30 minutes. Finely divided metallic uranium, various uranium compounds, and numerous other hygroscopic and pyrophoric samples have been successfully handled in this system. (auth)

568 (TID-20894) SODIUM-HEATED STEAM GENERATOR DEVELOPMENT. Progress Report No. 13, May 1964. (Babcock and Wilcox Co., Barberton, Ohio). Contract AT(11-1)-1280. 80p. Dep.(mn); $3.00(cy), 2(mn) OTS.

The preliminary design work on the full-size steam generator is complete. The design work under Phase I is 76% complete. (auth)

569 (TID-21246) PIQUA ELK RIVER REACTORS SPENT FUEL SHIPPING CASK DESIGN REPORT. (Knapp Mills Inc., Wilmington, Del.). [1962]. Contract AT(11-1)-1028. 179p. Dep.(mn); $5.00(cy), 3(mn) OTS.

The shipping cask system is designed to ship 19 fuel assemblies from both the Piqua and Elk River Reactor plants, by rail or truck. The design analysis includes shielding analysis, thermal analysis, stress analysis, fire analysis, and criticality analysis. The loading-unloading procedures and test program are described. (D.L.C.)

570 (WAPD-T-1688) REMOTELY OPERABLE DIMENSIONING EQUIPMENT ACCURATE TO ±0.0002 IN. J. D. Eichenberg, F. J. Lennon, and K. L. Rupp (Westinghouse Electric Corp. Bettis Atomic Power Lab., West Mifflin, Penna.). June 1964. Contract AT-11-1-GEN-14. 22p. (CONF-654-5). Dep.(mn); $1.00(cy), 1(mn) OTS.

From American Nuclear Society Meeting, San Francisco. Nov.-Dec. 1964.

Instruments have been designed and constructed to remotely measure the dimensions of irradiated samples with an accuracy of plus or minus 0.0002 in. The zero to three inch range instrument utilizes a Bausch and Lomb Optical Micrometer coupled with a BAPL designed movable bottom anvil and positioning table. The three to thirty inch range instrument, designated as an Ultramicrometer, was designed and constructed by Bettis. The design objectives have been achieved and both instruments have been in service in the high level cells at Bettis for over one year. (auth)

571 ELECTROMAGNETIC PERFORMANCE OF NIOBIUM-STANNIDE RIBBON. H. C. Schindler and F. R. Nyman. RCA Rev., 25: 570-81(Sept. 1964).

The degree of electromagnetic stability of niobium-stannide ribbon is a function of the processing. Unstable or partially stable ribbon can be stabilized by electroplating the surface with copper at low plating-current densities. The current-carrying capacity, J, of copper-plated Nb_3Sn ribbon can be expressed as a function of the transverse magnetic field, H, by $J = \alpha/(B_0 + H)$, where $\alpha = 30 \times 10^6$ kilogauss-amperes per square centimeter and $B_0 = -7$ kilogauss. The performance of a magnet wound with niobium–stannide ribbon can be predicted from the critical data of the ribbon material. Solenoids wound with this ribbon have generated fields of 107 kilogauss in a one-inch bore. (auth)

572 ADVANCES IN THE DEVELOPMENT OF HIGH-INTENSITY ION SOURCES. Ivan Sevarac ("Boris Kidrich" Inst. of Nuclear Sciences, Belgrade). Tehnika (Belgrade), 18: 1620-7(1963). (In Serbo-Croatian)

Notes on ion sources and their range of application, general operational principles, characteristics, and the intervals of the principal parameters of their operation are given. Some elementary relations between the geometric configuration and the principal parameters of ion sources are also given. A treatment is then given of some ion sources used in charged particle accelerators, as plasma sources, in devices for the study of high current discharge, in research on thermonuclear plasma, for ionic propulsion, or for plasma jets in space propulsion. (tr-auth)

573 A GRAPPLING DEVICE. Norman Bradley and Jack Jones (to United Kingdom Atomic Energy Authority). German Patent 1,167,503. Apr. 9, 1964. Priority date Nov. 20, 1958, Great Britain.

The piston operating the device is arranged to be displaced relative to a limiting cylinder between positions corresponding to the grappling and release positions of the grappling device. The piston is maintained in one position by means of a pressure differential between ambient pressure and a suction. A secondary air aperture from ambient pressure to the suction side of the piston causes the pressure differential to drop to zero when the suction is shut off. A control means in the form of a compression spring is provided. Normally rendered ineffective by the pressure differential, it causes the piston to be displaced to the other one of the two positions when the pressure differential equals zero. (Gmelin Inst.)

574 A RADIATION CIRCUIT. V. E. Drozdov, Yu. S. Ryabukhin, and I. A. Shvarts. Russian Patent 162,258.

An irradiation assembly is described in which the gamma emitter is incorporated in small, solid spheres that are moved pneumatically. (D.C.W.)

Heat Transfer and Fluid Flow

Refer also to abstracts 1821 and 1828.

575 (AEEW-R-244) AN EXPERIMENTAL INVESTIGATION INTO HEAT TRANSFER AND PRESSURE DROP PROPERTIES OF GASEOUS SUSPENSIONS OF SOLIDS. R. I. Hawes, E. Holland, G. J. Kirby, and P. R. Waller (United Kingdom Atomic Energy Authority. Reactor Group. Atomic Energy Establishment, Winfrith, Dorset, England). June 1964. 32p. Dep.; $0.90(BIS), 4s. 6d.(HMSO).

Heat transfer and pressure drop correlations have been obtained for flowing suspensions of graphite powder in nitrogen gas in a plain ½ in. diameter tube. Pressure drop data for an argon/graphite suspension have also been obtained in the same tube. The heat transfer data are correlated in the form of a Colburn equation for clean gases with the addition of terms to show the dependence on the solids loading ratio of the suspension and the tube length/diameter ratio. Similarly, the pressure drop data are correlated in the form of the clean gas pressure drop with a modifying factor to allow for the effect of the added solids. The heat transfer data show good agreement with that measured by Babcock and Wilcox Ltd., Renfrew at higher pressures using graphite/carbon dioxide suspensions and also with that measured by Schluderberg of Babcock and Wilcox Company, U.S.A. The pressure drop results are in reasonably good agreement with the results obtained by Babcock and Wilcox Ltd. (Renfrew) but are at variance with those of Schluderberg. (auth)

576 (AEEW-R-343) FILM COOLING OF VERTICAL FUEL RODS. G. L. Shires, A. R. Pickering, and P. T. Blacker (United Kingdom Atomic Energy Authority. Reactor Group. Atomic Energy Establishment, Winfrith, Dorset, England). May 1964. 48p. Dep.; $.60(BIS), 8s.(HMSO).

Spray cooling of vertical rods was studied at low heat fluxes appropriate to the removal of fission product heating following a reactor shut down. A series of tests were made at atmospheric pressure using electrically heated rods, both singly and in a seven rod cluster, cooled by a falling film of water. Four modes of film breakdown were observed: progressive evaporation of the film; dry-patch formation due to surface tension effects at high inlet subcooling; stripping of the film by the flooding action of counterflow steam; and the disruption of the film on a hot rod caused by sputtering. Each of these phenomena is described in relation to the application of film cooling to long vertical fuel rod clusters. (auth)

577 (AFOSR-64-0719) CONCEPT OF FIELD MODES IN FLUID MECHANICS. Carl Kaplan (Johns Hopkins Univ., Baltimore). Apr. 1964. Contract AF 49(638)-496. 58p. (AD-600964). $1.50(OTS).

A method for studying the behavior of magnetohydrodynamic fields was used to explore steady incompressible two-dimensional linearized fluid flow with finite viscosity. This method, based on the central idea of splitting the behavior of a flow field into independent modes of behavior, is then applied to the often-treated and well-known case of viscous incompressible flow over a semi-infinite flat plate immersed in an unbounded uniform stream. (auth)

578 (AGN-8112) ALKALI METALS EVALUATION PROGRAM. Quarterly Progress Report, April 1–June 30, 1964. C. R. Fisher and P. Y. Achener (Aerojet-General Nucleonics, San Ramon, Calif.). Aug. 17, 1964. Contract AT(04-3)-368. 56p. Dep.(mn); $3.00(cy), 2(mn) OTS.

Task A of the program includes a study of boiling and condensing heat transfer and two-phase flow characteristics of rubidium and cesium; Task B is concerned with the thermophysical properties of rubidium and cesium; Task C is to determine the heat transfer and flow behavior of potassium; and Task D is concerned with the thermophysical properties of potassium. Results of the rubidium swirl flow heat transfer testing, the analytical studies and design progress of the thermal diffusivity and liquid viscosity experiments, the progress made toward the completion of the PVT apparatus, and the work done towards the measurement of the latent heat of vaporization of potassium are discussed. (auth)

579 (CEA-R-2464) AMELIORATION DU TRANSFERT DE CHALEUR PAR L'EMPLOI DE SURFACES CORRUGUEES. (Improvement of Heat Transfer by the Use of Corrugated Surfaces). Jean Garguad and Gargaud Paumard (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). Aug. 1964. 66p. Dep.(mn).

This experimental work is designed to determine the friction coefficient and the Margoulis number of internally or externally corrugated cans cooled by air or CO_2 under forced convection, when the Reynolds' number is between 1.5×10^4 and 3.5×10^6. Different corrugation profiles have been examined; they are made up of variously shaped threading, of rings, of transverse fins, of very small herring-bone fins, and of undulations. Two types of test have been carried out: (1) tests in annular spaces using CO_2 or air, where the gas circulates between an electrically heated corrugated nucleus having a constant flux and a smooth exterior channel. (2) tests on internally corrugated tubes heated by an external water current and cooled by an internal current of pressurized CO_2. The first type of test requires probe-measurement of the speeds and the temperatures in the fluid in order to obtain a friction coefficient and a Margoulis' number which are characteristic of the corrugated surface. These coefficients, on the other hand, are given directly by the second type of test. This work shows the role and the importance of the various geometric and aerodynamic parameters such as relative roughness, the reduced pitch (ratio of the pitches at the height of the corrugation), and the Reynolds' number. (auth)

580 (EURAEC-1123) SOME RESULTS OF MEASUREMENTS IN STEADY AND NON-STEADY STATE IN AN ANNULAR GEOMETRY OBTAINED IN THE TWO-PHASE FLOW PROGRAMME. Special Technical Report No. 16. M. Bogaardt and C. L. Spigt (Eindhoven, Netherlands. Technische Hogeschool). June 1964. Work Performed under United States–Euratom Joint Research and

Development Program. Contract 032-60-11-RDH. 25p. (CONF-537-5; WW-016-R-69). Dep.(mn); $1.00(cy), 1(mn) OTS.

From USAEC–EURATOM Conference on Two Phase Flow Problems, Washington, D. C., Apr.-May 1964.

Some results of an experimental study of the characteristics in steady states and the onset of instabilities in a vertical boiling channel with natural convection are presented. An attempt is made to define a suitable criterion for the onset of instabilities using autocorrelations and power density curves. The character of the instabilities is studied by means of a multistage impedance void detector. The onset of instabilities is presented as a function of pressure and subcooling. Preliminary results are shown of the measurement of the transfer function from power to void. (auth)

581 (GEAP-4634) TWO-PHASE PRESSURE LOSSES, FINAL REPORT: 1. PRESSURE LOSSES ACROSS LARGE EXPANSIONS AND CONTRACTIONS. 2. PRESSURE DROP WITH HEAT ADDITION. 3. GENERAL CONCLUSIONS. E. Janssen and J. A. Kervinen (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). July 1964. Contract AT(04-3)-189. 56p. Dep.(mn); $3.00(cy), 2(mn) OTS.

The two-phase pressure change was measured across expansions from 2-inch- to 3½-inch-, 4½-inch-, and 5½-inch-ID pipes; and across contractions from 3½-inch-, 4½-inch-, and 5½-inch- to 2-inch ID pipes. Axis of the test section was vertical for all runs. Tests were with steam–water at 600 to 1400 psia, flows after the expansions from 0.125×10^6 to 0.75×10^6 lb/hr-ft², and qualities from 3 to 20 percent. Calculated values of pressure recovery past the expansions were compared with measured values, both single- and two-phase runs. Most calculated points were within 25 percent of measured. The two-phase pressure drop was measured along an internally-heated annular geometry in vertical flow, $D_1 = 0.375$ inch, $D_2 = 0.875$ inch, L = 70 inches. Tests were with steam–water at 600 to 1400 psia, flows from 0.5×10^6 to 1.7×10^6 lb/hr-ft², heat fluxes from 0.55×10^6 to 0.8×10^6 Btu/hr-ft², and exit qualities from 2 to 20 percent. Pressure drop increases as quality increases, except at the lowest flow. The effect of heat flux on pressure drop is very slight (less than the scatter in the data). Calculated and measured pressure drop agree with ±10 percent at all three flows. The momentum model used for the calculations is based on the following assumptions: (a) Velocity of each phase can be represented by a single value. (b) Void fraction and wall shear are functions of local conditions, the same as for the straight channel with no heat addition. (c) Thermodynamic equilibrium exists at every section along the channel. This model is useful both for predicting pressure recovery and pressure loss across large as well as small expansions, provided the flow is fully developed, and for predicting pressure drop with heat addition. (auth)

582 (NASA-CR-54050) ALKALI METALS BOILING AND CONDENSING INVESTIGATIONS. VOLUME I. EXPERIMENTAL PROGRAM. Final Report, January 1, 1961–June 30, 1962. R. D. Brooks, ed. (General Electric Co. Missile and Space Div., Cincinnati). Contract NAS 5-681. 307p.

Studies were carried out on the boiling of potassium and sodium at temperatures up to 2200°F and condensing up to 1600°F. A description is given of the three test facilities used in the experiments and of the design considerations. Instrumentation and measurement problems are discussed, and some results are reported along with pool boiling experiments. (D.L.C.)

583 (NP-14431) WATER CONDENSING TESTS. P. Griffith and E. Kulinski (Thompson Ramo Wooldridge Inc., Cleveland). Oct. 5, 1960. 63p. (ER-4200)

Water condensing experiments were conducted in order to study the problems associated with condensing alkali metals in a zero-gravity space environment. The instabilities (pressure variations and slug flow) were studied for both single-tube and multi-tube condensers under a variety of gravity fields. The design of a condenser for flow stability for space vehicles is discussed. (D.L.C.)

584 (NP-14440) ACOUSTIC NOISE FROM A CAVITATING VENTURI. Technical Report No. 1. R. Garcia, F. G. Hammitt, and M. J. Robinson (Michigan. Univ., Ann Arbor. Coll. of Engineering). June 1, 1964. 47p. (ORA-06110-1-T)

A stainless steel acoustic probe for detecting cavitation incipience, degree, and intensity in a flowing fluid has been developed and tested in both mercury and water tunnel facilities. The barium titanate crystal attached to one end of the probe is used to observe the sound pattern generated by the collapsing bubbles in the venturi test section contained in each loop. The voltage generated by the crystal gives definitive information as to the degree of cavitation present. The probe is suitable for use in water-Plexiglas, mercury-Plexiglas, and high temperature liquid metal-steel systems. It was found for both mercury and water that the signal from the probe increases as the degree of cavitation becomes more intense. For mercury the cavitation signal is proportional to the velocity raised to the 1.7 power, while in the case of water the appropriate exponent is 1.5. For mercury the cavitation signal decreased by 15% when the temperature was raised from 70°F to 500°F. The frequency of the observed voltage waveforms is approximately 2 kc, somewhat higher than the frequency of the loop and pump noises present. This frequency is indicative of the frequency of the noise produced by the collapsing bubbles. The probe is operational and can be easily and quickly installed. (auth)

585 (NP-14441) CAVITATION DAMAGE MEASUREMENTS BY RADIOTRACER ANALYSIS. Internal Report No. 23. Frederick G. Hammitt, Willy Smith, Juan Nieto, and M. John Robinson (Michigan. Univ., Ann Arbor. Coll. of Engineering). Feb. 1964. 39p.

No method exists at present for continuous measurement of the cavitation-erosion damage on metallic specimens. By using radioactive isotopes, the development of a technique that would give information not only on wear rate but on debris particle size and composition was attempted. Samples of 302 stainless steel and 1010 carbon steel were irradiated and exposed to cavitation in a venturi. Mercury and water were used as test fluids. Meaningful data were obtained particularly with respect to particle size distribution and debris components, and their variation with particle size. In the water tests a useful measure of damage rate also was attached. The mercury tests indicated the possible technological difficulties which may be encountered in the application of this method. These are primarily concerned with the capability of the liquid to wet the debris particles and to maintain a uniform slurry. (auth)

586 (NYO-3304-2) INVESTIGATION OF TWO-PHASE FLOW AND BURNOUT. Quarterly Progress Report, June 15–September 15, 1964. Report No. 497. M. Suo, P. Goldberg, A. Bergles, L. Clawson, and J. Bourne (Dynatech Corp., Cambridge, Mass.). Sept. 30, 1964. Contract AT(30-1)-3304. 62p. Dep.(mn); $3.00(cy), 2(mn) OTS.

Flow regimes and flow stability at burnout for some simple geometries are being studied. The experimental facility is being instrumented. The initial experimental program is planned. Flow regime models are evaluated, with cross-checking applied. A summary of the expected flow regimes is presented. The problem of nucleation in annular flow is delineated. An analysis of the stability of the test section is presented. (auth)

587 (SAN-1008) VAPOR NUCLEATION ON SURFACES SUBJECTED TO TRANSIENT HEATING (thesis). Stanislav Fabic (California. Univ., Berkeley. Inst. of Engineering Research). Aug. 1964. Contract AT(11-1)-34. 176p. Dep.(mn); $5.00(cy), 3(mn) OTS.

A model is presented which brackets the temperature of the heating surface at the incidence of boiling, when the liquid is degassed. It is assumed that nucleation takes place at the surface cavities or pits, in which vapor was trapped before the heating transient. The heating surface was examined under a microscope, and an abundance of cavities of the type and size considered by the model was found. The mechanism assumed to be responsible for both trapping of

vapor and for its nucleation superheat is based on the contact angle hysteresis; the contact angle between the liquid/vapor interface and the cavity wall is greater than 90° while the interface is advancing over the dry wall, and smaller than 90° while the interface is receding over the previously wetted wall. During heating the liquid/vapor interface changes its shape from concave to convex (with respect to the liquid) and rushes out of the cavity immediately after the interface forms the receding contact angle with the cavity wall, at which time the act of nucleation is completed. The model predicts the vapor pressure (p_v) at nucleation, in terms of the liquid pressure (p_l) and the surface tension (σ) at nucleation, the interface contact angles and the maximum value of $(p_l - p_v)/\sigma$ that occurred during heating. The upper and lower bounds arise from the consideration of the shape of the cavity mouth. Except for very fast transients (such as caused by the heat generation which increases exponentially with a period shorter than 5 msec), the heating surface temperature corresponds with the saturation temperature of the nucleating vapor. Data obtained from the transient boiling experiments conducted at the Reactor Heat Transient Project were used to test the model. Nucleation temperatures measured in some 120 tests were found to be fairly well bracketed by the model. In seventy per cent of the cases, the time of first bubble, based on the predicted mean nucleation temperature, was within 5% of the measured time of first bubble; it was within 10% in 90% of the cases. Differences between the measured and the predicted time of first bubble were less than one tenth of the exponential period in fifty per cent of the cases, and less than two tenths of the exponential period in eighty per cent of the cases. The existing nucleation models were also examined; some were found to be unsuitable for application to transients while the others gave poorer results when compared with test data. The prediction of the incidence of boiling or of the time of first bubble is especially important for the safety analysis of nuclear reactors in which the coolant serves as a moderator, so that the replacement of the latter by steam acts as an efficient shutdown mechanism. The upper limit for the surface temperature at nucleation will, in such cases, provide the needed degree of conservatism. (auth)

588 (TID-21221(p.7-86)) THERMOHYDRODYNAMIC STUDIES ON TWO-PHASE FLOW. R. Morin (European Atomic Energy Community).

A large number of studies was carried out on hydraulic instability and critical heat flux which limit the operation of boiling water reactors. These studies include: instabilities in boiling water loops, application of the "Vapotron" concept to boiling reactors, influence of flow pattern at test section inlet and of L/D ratio on critical heat flux, use of spiral flow to improve heat transfer, and characteristics of steam–water mixtures as reactor coolants. Theoretical considerations, equipment, and results are described in some detail. (D.L.C.)

589 (UCRL-11629) ANALYSIS OF GAS-PHASE MASS TRANSFER IN TURBULENT FLOWS (thesis). Darshanlal T. Wasan and Charles R. Wilke (California. Univ., Berkeley and California. Univ., Berkeley. Lawrence Radiation Lab.). Sept. 1964. Contract W-7405-eng-48. 236p. Dep.(mn); $6.00(cy), 4(mn) OTS.

Submitted by Darshanlal T. Wasan.

A general treatment of mass transfer between a smooth pipe wall and a fully developed turbulent flow is presented. An analysis of simultaneous exchange of mass and heat from single cylinders is made. A new correlation for the psychrometric ratio is presented based in part on the treatment of transfer of heat and mass in pipe flow. The proposed correlation compares favorably with available experimental data. Numerical solutions were developed for a forced-convection-diffusion system involving gas-phase non-equimolal turbulent diffusion in pipes with a constant concentration at the wall. Through these solutions it is concluded that the product of the gas-phase mass transfer coefficient and the film pressure factor at constant Schmidt and Reynolds numbers is nearly constant in the mass transfer entry region as well as in the fully developed regions. Experiments on vaporization of water into turbulent flow of air in a short cylindrical section are reported. The concentration, temperature, and velocity profiles are presented. Observations of velocity profiles under the vaporization conditions revealed no significant effect of mass transfer or turbulent velocity fields at mass transfer fluxes up to 5×10^{-6} gm moles/sq cm-sec. Experimental values of the mass transfer Stanton number were found to agree with the numerical solutions of the diffusion-convection equation. (auth)

590 A GENERALIZED CORRELATION FOR PREDICTING THE HEAT TRANSFER CRISIS WITH STEAM-WATER MIXTURES. S. Bertoletti, G. P. Gaspari, C. Lombardi, G. Peterlongo, and F. A. Tacconi (Laboratori CISE, Milan). Energia Nucl. (Milan), 11: 571-2(Oct. 1964).

The critical heat flux for film disruption in steam–water flows is studied parametrically. The parameters are found for the special cases of flows in round tubes, rectangular channels, annuli, and clusters. Extension of the results to Freon 12 flows is discussed. (T.F.H.)

591 EXPERIMENTAL STUDY OF LAMINAR CONVECTION IN THE CHANNEL BETWEEN PARALLEL PLATES WITH UNIFORM HEAT SOURCES IN THE FLUID. J. L. Novotny and E. R. G. Eckert (Univ. of Minnesota, Minneapolis). Intern. J. Heat Mass Transfer, 7: 955-68(Sept. 1964).

Heat-transfer results for the free convective flow of a heat-generating fluid in a vertical parallel-plate channel were obtained through use of a Zehnder-Mach interferometer. The experiments were carried out with a parallel-plate channel, open at the top and bottom, suspended in a large tank of dilute electrolyte. The heat-transfer characteristics of the channel were studied starting from an initial state of uniform temperature in the whole system (no flow) to the onset of quasi-steady convection when a step change in heat generation is applied to the fluid initially between the walls of the channel. Experimental results are presented for channel spacings of 0.197 and 0.745 in and for an internal heat generation rate of approximately 13,000 Btu/hr ft^3. These results were compared with theoretical analyses for the early transient period and for the final quasi-steady state. The agreement between experiment and theory indicates that the heat transfer for the range of parameters studied can be predicted adequately for the whole transient period. (auth)

592 THE FLOW OF CONDUCTING LIQUIDS IN A HOMOGENEOUS EXTERNAL MAGNETIC FIELD BETWEEN COAXIAL CYLINDERS. József Demjén and János Firtkó (Technical Univ. of Heavy Industry, Miskolc, Hungary). Magy. Fiz. Folyoirat, 12: 255-9(1964). (In Hungarian)

Conducting liquids, such as liquid metals, flowing in a magnetic field are retarded by the eddy currents, the effects of which are described in this respect as "magnetic viscosity." This phenomenon is of importance for the technological application of liquid metals, as for instance, as cooling agents for reactors. The problem was studied by means of an experimental arrangement consisting of coaxial cylinders and a channel placed in a direction perpendicular with respect to it. The channel had a quadrilateral cross section while the homogeneous magnetic field was kept parallel with respect to the axis of the cylinders. The liquid metal was circulated by means of Lorentz forces. After determining the current density and the distribution of the electric field, the components of the tension tensor and the effect of the viscosity forces was directly derived. A number of nonstationary problems was also investigated by means of the same experimental arrangement; it was found possible to measure the surface distribution of the velocity without interfering with the flow. By using an open channel, the viscosity of a nonconducting liquid, which is immiscible with the conducting one, can be also determined; in this case, the conducting liquid plays the role of a motor. (TTT)

593 AN EXAMPLE OF HYDROMAGNETIC INDUCTION. J. Foerste (Institut für Angewandte Mathematik und Mechanik, Deutsche Akademie der Wissenschaften, Berlin).

Monatsber. Deut. Akad. Wiss. Berlin, 6: 561-72(1964). (In German)

Through a straight tube with circular cross section flows an incompressible, viscous, electrically conducting fluid. It was assumed that the flow is not influenced by a magnetic field. Under these conditions the influence of the flow on the magnetic field was examined. The magnetohydrodynamic equations are written in a dimensionless form. The boundary-value problem was formulized to describe the magnetohydrodynamic flow and solved. Stationary flow was also checked against the assumptions. (M.C.G.)

Materials Testing

594 (DP-910) NONDESTRUCTIVE TEST OF CARBON BEDS FOR REACTOR CONTAINMENT APPLICATIONS. Progress Report, January–March 1964. David R. Muhlbaier (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Aug. 1964. Contract AT(07-2)-1. 21p. Dep.; $1.00(cy), 1(mn) OTS.

Development of a standardized, nondestructive and more generally applicable test for installed carbon beds that are used in reactor containment facilities was started. Tests showed that the limitations imposed on air velocity and H_2O content of the carbon by an earlier testing method were reduced significantly when Freons with higher boiling points were substituted for Freon-12. (auth)

595 (EURAEC-1151) NON-DESTRUCTIVE WELDING. Quarterly Report No. 10, October 1–December 31, 1963. (Rontgen Technische Dienst N. V., Rotterdam). July 15, 1964. Work Performed under United States–Euratom Joint Research and Development Program. Contract 045-61-5-RDH. 25p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Radiographic testing of steel testblocks ranging from 100 to 300 mm is analyzed. The speed of different film types was established for the radiation energy involved. The image quality obtained by combinations of different tantalum, lead, and salt screens was compared. The best image quality was achieved with a tantalum screen of 1.5 mm in front and no screen at the back. This was also the case with a steel thickness down to 20 mm. Multiple film technique was tried with 2 and 3 films exposed simultaneously. It was found that the image quality of the film added is always poorer and so is the definition of the combined films. The contrast, however, is increased so that for a given exposure time some gain in image quality may be expected. The wire visibility for thicknesses from 20 to 300 mm varies from 3 to 0.4%. (N.W.R.)

596 (EURAEC-1152) NON-DESTRUCTIVE WELDING. Quarterly Report No. 11, January 1–March 31, 1964. (Rontgen Technische Dienst N. V. Rotterdam). July 24, 1964. Work Performed under United States–Euratom Joint Research and Development Program. Contract 045-61-5 V11. 28p. Dep.(mn); $2.00(cy), 1(mn) OTS.

The weld in testpiece 300-AB was manually and semi-automatically scanned by the reflection method to reveal the defects purposely made. Clear indications of the incomplete penetration and lack of fusion were obtained. Other defects were difficult to interpret due to a multitude of echo indications. Optimum indications were obtained when the beam axis was at an angle of 15° to the length-axis of the weld. This is explained by the weld preparation chosen. The weld examined is being cut out of the test piece for closer examination of cross sections as a check on the ultrasonic findings. (N.W.R.)

597 GAMMA RADIOGRAPHY AT NEW ZEALAND GEOTHERMAL STEAM POWER STATION. C. M. Gray (Australian Atomic Energy Commission). At. Energy Australia, 7: No. 3, 7-11(July 1964).

The rapid increase in activity aimed at the development of geothermal steam-yielding projects engendered by the success of the Italian and New Zealand projects is discussed. Special attention is given to the New Zealand project at Wairakei. Steam mains running from the producing area to the power station contain eight miles of 20 in. dia seamless steel pipework. Expansion loops are provided at 1000 ft intervals. In the longest mains the expansion to be accommodated is about 20 ft. The project constitutes a major exercise in pipework and welding and, consequently, nondestructive inspection has had to cover every inch of every weld involved. The inspection of all the welding in the pipework has been carried out by gamma radiography using ^{192}Ir sources since the beginning of construction of the generating project. A method was devised whereby a radioisotope source moves axially through long runs of pipework in such a way that the source can be accurately positioned where required. The basic features of the equipment used are illustrated. (P.C.H.)

598 NONDESTRUCTIVE TESTING: BACKGROUND, THEORY, AND APPLICATION. Frank L. Greenfield and Stuart F. Greenfield (American Construction Testing Inst. of New York, Inc., Staten Island, N. Y.). Trans. N. Y. Acad. Sci., 26: 453-73(Feb. 1964).

The use of radiation, especially x and γ rays and neutrons, in this field are reviewed, and safety features with use of such sources are discussed. The development of instruments with high kilovoltage in x-ray testing equipment and the use of radioactive elements, namely, isotopes with one-megavolt capactiy and up, give the field of engineering a microscopic technique to diagnose and detect the type and quality of materials used in the construction and products fields. Nondestructive testing utilizes four basic energy media. Radiation, by means of light and uv sources, is used in determining, for example, voids in nonferrous material by means of fluorescent particle testing. Magnetism plays an important part of the nondestructive testing techniques in the use of magnetic energy to form magnetic waves and, in turn, magnetize the molecular particles of the ferrous materials. The use of ultrasonics and its concomitant sound waves are utilized to determine internal flaws in ferrous materials which could not be visually examined. However, the most used media of energy in nondestructive inspection is that of the x- and γ-ray sources. The material, type, location, shape, and size of discontinuities are the guides to the use of the medium used for inspection; also to be taken into account is the fact that the responses to the different energy media vary and will govern which energy will be used. X-ray sources are used in the detection of internal flaws and defects, cracks, seams, weld porosities, holes and inclusions, assemblies of materials, lack of bond, and thickness variations. An x-ray unit is used where the source required reaches the kilovolt range and is most effective in the radiographing of materials up to 2½ in. thick. In reaching two-in. and beyond thicknesses, lead and/or tungsten screens are employed to prevent fogging of the film when the higher kilovoltage is applied. Beyond two inches it is more practical to use a γ-ray source in that the exposure time is shortened and the heating of the tube in the x-ray unit requires a cooling-off period, with the result of limited radiographic production. The x-ray technique is better utilized on thin sections, often has a higher sensitivity than other forms of nondestructive analyses, and avails the technician with fluoroscopy techniques and adjustable energy levels. Limitation on the use of the x-ray source is the requirement of a power source where such may be unavailable. The γ-ray source and its resultant radiograph detects a variety of flaws that other nondestructive techniques cannot reveal. The unit is portable in its use and does not require an outside power source, which limits the testing scope of the x ray unit. The γ-ray source has a lower initial cost than the x-ray source unit, and may be used continuously without regard to over-heating of tubes or other unit components. γ Radiation has its limitations in that there is one energy level per source, e.g., 10 or 50 C. A higher measure of caution is required and a greater radiation hazard is present. Trained technicians and radiographers must receive specialized training in the use of the source and in the determination of the inverse square law of distance of the source in regard to radiation absorption. A training program is discussed which involves not merely the operational use of the instruments but also the indoctrination of personnel regarding precautionary measures which must be instilled to

maintain their safety. The training program covers the technical instruction of radiographic operational procedures and orientation on the rules and regulations pertaining to the radiation protection and safety program. This instruction consists of formal as well as on-the-job training in the practice of handling instruments emitting the four basic energy media of light, magnetism, ultrasonics, and x and γ radiation. Further training for specialists in the protection of personnel also consists of the instruction in the use of instruments to calibrate radiation emission and absorption in the test areas and to personnel. The program, upon completion of the formal and on-the-job training, requires both written and oral examinations conducted jointly by the radiographic supervisor and the radiation protection officer. The initial training period is composed of a 30-day trial in which the applicant is familiarized with the aforementioned topics and operations. After the completion of the probationary period, the applicant will then be permitted to take the written examination for the position of assistant radiographer. (BBB)

GEOLOGY AND MINERALOGY

General

Refer also to abstract 678.

599 (CONF-759-1) OXYGEN ISOTOPE STUDIES OF MINERALS IN STONY METEORITES. Hugh P. Taylor, Jr., Michael B. Duke, Leon T. Silver, and Samuel Epstein (California Inst. of Tech., Pasadena). [1964]. Contract AT(04-3)-427. 43p. Dep.(mn); $2.00(cy), 1(mn) OTS.

From Geophysical Union Annual Meeting, Washington, D. C., Apr. 1964.

Oxygen isotope analyses demonstrate the following sequence (as in terrestrial igneous rocks) of increasing ^{18}O content for coexisting minerals of stony meteorites: olivine, pyroxene, plagioclase, free silica. Except for the carbonaceous chondrites, the $^{18}O/^{16}O$ ratio of a given mineral is quite uniform in each meteorite class. Differences exist between classes of meteorites, however, as well as between certain meteorites and terrestrial igneous rocks. For example, the $^{18}O/^{16}O$ ratios of meteoritic pyroxenes vary from $\delta = -0.5$ per mil to $\delta = +8.6$ per mil (relative to SMOW), whereas pyroxenes in 8 terrestrial igneous rocks have δ-values which range only from +5.5 to +6.6. The oxygen isotope data suggest a separation of the stony meteorites into three groups, as follows: (I.) Basaltic achondrites, hypersthene achondrites, and mesosiderites with pyroxene δ-values of 3.7 to 4.4. (II.) Hypersthene-olivine chondrites, bronzite-olivine chondrites, enstatite chondrites, enstatite achondrites, and nakhlites with pyroxene δ-values of 5.3 to 6.3. (III). Types I, II, and III carbonaceous chondrites, and ureilites with highly variable olivine and pyroxene δ-values. It is suggested that the meteorites within each of these three groups are genetically related to one another, but that the three groups may themselves be only distantly related or unrelated. The chondrites have $^{18}O/^{16}O$ ratios similar to their terrestrial analogs, the ultramafic rocks. However, whereas terrestrial basaltic rocks are 1 to 2 per mil richer in ^{18}O than ultramafic rocks, the basaltic meteorites are 0.5 to 1.5 per mil lower than chondrites; thus there are serious restrictions placed on any postulated derivation of the basaltic meteorites from chondrites. In addition, the carbonaceous chondrites cannot be simply normal chondrites which have suffered a low-temperature alteration. The olivine in carbonaceous meteorites is lower in $^{18}O/^{16}O$ and isotopically much more variable than chondrite olivine, implying that it is derived from a distinctly different source material. (auth)

600 (CONF-759-2) O^{18}/O^{16} RATIOS OF SOME CHONDRITIC METEORITES AND TERRESTRIAL ULTRAMAFIC ROCKS. J. H. Reuter, S. Epstein, and H. P. Taylor, Jr. (California Inst. of Tech., Pasadena). [1964]. Contract AT(04-3)-427. 18p. Dep.(mn); $1.00(cy), 1(mn) OTS.

From Geophysical Union Annual Meeting, Washington, D. C., Apr. 1964.

Oxygen isotopic analyses were made on the silicate portions of 27 chondrites, 2 pallasites, and 10 terrestrial ultramafic rocks using a fluorine extraction procedure. The presence of sulfides, free iron, iron oxides (formed by weathering of the meteorites), and olivine contributes difficulties to the extraction of the oxygen. Consequently, before fluorinations were done the samples were subjected to several pretreatments. Heating in vacuum and in an atmosphere of hydrogen removed the oxygen added to the meteorites during weathering. Dry chlorination of 350°C removed the iron and sulfide phases. Fusion of the samples with known amounts of quartz of known $^{18}O/^{16}O$ ratio converted the olivine to a pyroxene glass and permitted attainment of 100 percent yields in the extraction of the oxygen. The total isotopic variation in the analyzed chondrites is only 1.2 per mil. The pallasite olivines are about 2 per mil lower in $^{18}O/^{16}O$ than the average chondrite. It is possible to detect some grouping within the 1.2 per mil range in the δ-values of the chondrites. For example, the average δ-value for the olivine-bronzite chondrites (H-type) is about 0.5 per mil lower than for the olivine-hypersthene (L-type) chondrites. Separated chondrules from 4 chondrites give essentially the same δ-values as the matrix. The δ-values for terrestrial dunites and olivines are within the range of δ-values reported by previous workers and are isotopically similar to the olivine-hypersthene chondrites. (auth)

601 (EUR-1837.f) MESURE DU DEBIT SOLIDE DES COURS D'EAU PAR CHARRIAGE AU MOYEN DE TRACEURS. (Measurements of the Bed Load Rate of Streams by Means of Tracers). J. L. Chauvin and J. Danion (France. Electricite de France, Paris). 1963. 28p. Dep.(mn)

Methods for studying the bed load of streams by tracers have been developed during these past years for palliating the insufficiency of previous methods that are briefly recalled. The first field experiments carried out by the National Hydraulic Laboratory contribute especially qualitative data about local bed load problems. A more recent campaign has, on the other hand, enabled a satisfactory indirect method to be drawn up for reackoning the bed load rate of pebbles, in the field of the partial bed load. Fundamental flume laboratory tests are proposed to ascertain the possibilities of transposing for measuring the solid transport the various methods currently utilized for discharge measurements by injecting tracers. A statistical model is moreover proposed for the migration of the bed particles having a uniform size composition. (auth)

602 (HW-81746(p.4.37-9)) SOIL PARAMETERS NECESSARY FOR SOLUTION OF PARTIALLY SATURATED FLOW PROBLEMS. L. C. King (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

The solution of problems involving flow through partially saturated porous media requires a knowledge of the three interrelated soil parameters: permeability, capillary pressure, and moisture content. It was concluded that the relationships may be expressed as two curves: moisture content as a function of capillary pressure and permeability as a function of capillary pressure. These relationships are shown to arise from the basic equation describing flow. (auth)

603 (HW-81746(p.4.42-7)) ANALYTICAL DESCRIPTION OF SOIL PARAMETERS FOR PARTIALLY SATURATED FLOW. L. G. King and A. E. Reisenauer (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Methods were derived for accurately fitting experimental data for soil permeability and moisture content as functions of capillary pressure by equations in closed form. The immediate utility of these equations is in the simplification of input data used to obtain accurate solutions to steady-state, partially saturated flow problems. Future applications, such as those related to transient-state waste flow problems (leaking waste tank or pipeline), appeared promising. (auth)

604 (HW-81746(p.4.47-9)) IN-PLACE MEASUREMENT OF PERMEABILITY IN HETEROGENEOUS SOILS. R. W. Nelson (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

An extended sequence of analysis is presented, which overcomes the computation problems associated with the determination of soil permeability distributions in heterogeneous media. The potential function, obtained from orthogonal regression methods, provides the permeability through integration of appropriate functions along flow paths, which are also found from the potential function. (auth)

605 (HW-81746(p.4.50-3)) EXTENSION AND SIMPLIFICATION OF STREAM FUNCTIONS FOR FLOW IN

HETEROGENEOUS POROUS MEDIA. R. W. Nelson (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

The stream functions derived previously for heterogeneous media were extended to give simplified equations for the velocity, in terms of the stream function pair, and for the flux distribution. In this form the flux equations are directly integrable and are therefore simple to use. (auth)

606 (HW-81746(p.4.53-61)) RIVER WATER BANK STORAGE AND EXCHANGE AT HANFORD. J. R. Raymond and D. J. Brown (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Information is presented on water behavior adjacent to fluctuating rivers concerning bank storage and river water penetration into ground water aquifers. Methods of investigation are discussed. Evaluation of storage and exchange was carried out for the Hanford side of the Columbia River. Total bank storage for a typical year was 2.0×10^9 ft^3 of which 36% was river water. Total river water in the aquifer was 2.9×10^9 ft^3. This volume was equivalent to only about 8 hr river flow, based on an average flow rate of 1×10^5 ft^3/sec. (auth)

607 (PG-Report-604) THE BIOLOGY OF THE SOLWAY FIRTH IN RELATION TO THE MOVEMENT AND ACCUMULATION OF RADIOACTIVE MATERIALS. VI. GENERAL HYDROGRAPHY, WITH AN APPENDIX ON METEOROLOGICAL OBSERVATIONS. E. J. Perkins, M. Bailey, and B. R. H. Williams (United Kingdom Atomic Energy Authority. Production Group. Chapelcross Works, Annon, Dumfriesshire, Scotland). 1964. 61p. Dep.(mn); $2.00(BIS); 10s.(HMSO).

General hydrographical conditions in the Solway Firth during the period June 1962 to December 1963 are described. Nutrient concentrations at the Newbie station were found to be deficient with respect to phosphorus and silica, but moderately rich with respect to NO_3-N and NO_2-N. The appendix contains meteorological data for the period covered by the Solway studies. The values obtained for the stations at Carlisle and Chapelcross are selected as typical of the estuary and compared with long term averages. The climatological trends during the period are summarized and it is deduced that temperatures throughout the period were generally below average. The annual totals of rainfall were found to be average, but the annual distribution was abnormal. (auth)

608 (PNE-112F(Pt.II)) SHOCK INDUCED TRANSITIONS. PART II. ENCAPSULATION AND RESULTS OF EXPOSING PETROLEUM INDUSTRY SAMPLES. Final Report. Robert T. Johansen, F. E. Armstrong (Bureau of Mines. Bartlesville Petroleum Research Center, Okla.); and J. Wade Watkins (Bureau of Mines, Washington. D. C.). Dec. 10, 1961. Project GNOME. 44p. Dep.; $2.00(cy), 1(mn) OTS.

A compilation of data is presented including descriptions of fluid and solid samples of petroleum-reservoir and organic materials exposed to the forces of a nuclear explosion in the Gnome event. The method of containment, fabrication of containers, emplacement of containers in drill holes, conditions of exposure, retrieval of samples, and summary of results are discussed. The condition of recovered samples, examples of failure of containers, conclusions, and recommendations for future sample-exposure programs also are given. (auth)

609 (PNE-3001) SUBSURFACE FRACTURING FROM A NUCLEAR DETONATION IN GRANITE. Final Report. Charles H. Atkinson (Bureau of Mines. Bartlesville Petroleum Research Center, Okla.). June 1964. Project SHOAL. 36p. Dep.; $2.00(cy), 3(mn) OTS.

A fracture-evaluation experiment in conjunction with the Shoal nuclear detonation in granite was undertaken to determine the extent of subsurface shock-induced fractures. Preshot and postshot geophysical logs in a hole drilled from the surface through the zone of fractures indicated that fractures extended at least 5.3 cavity radii laterally from the point of detonation. Quantitative measurements of permeability increases resulting from the detonation were planned, but were not completed because of adverse test-hole conditions. General descriptions of the Shoal Project, geology of the test site, and other effects of the detonation are included. (auth)

610 (PNE-5001P) ENGINEERING GEOLOGY OF BUCKBOARD MESA, NEVADA TEST SITE. Interim Report. D. C. Banks and R. T. Saucier (Waterways Experiment Station, Vicksburg, Miss.). July 1964. 146p. Dep.; $4.00(cy), 3(mn) OTS.

Data are presented which were collected during the various site selection studies and preshot and postshot investigations pertaining to all cratering studies on Buckboard Mesa. The data include local geology, physical properties of basalt, and geophysical logging. (D.L.C.)

611 OXYGEN-ISOTOPE RATIOS IN ANTARCTIC SNOW, FIRN, AND ICE. Samuel Epstein, Robert P. Sharp, and Irene Goddard (California Inst. of Tech., Pasadena). J. Geol., 71: 698-720(Nov. 1963).

$^{18}O/^{16}O$ ratios in 550 specimens of snow, firn, and ice predominantly from West Antarctica were determined. Identification of annual layers in Antarctic snow and firn by O-isotope variations is undoubtedly complicated by wind action. Nonetheless, $^{18}O/^{16}O$-ratio curves with seemingly normal seasonal characteristics obtained at the South Pole, Byrd, Little America V, and Wilkes satellite stations consistently suggest accumulation rates 20–100% greater than determined by surface measurements and pit stratigraphy. Comparative annual accumulation values in cm depth of water (values derived from $^{18}O/^{16}O$ determinations in parentheses) are as follows: South Pole, 7 (15); Byrd, 14-18 (36); Little America V, 15.5-24 (30); and Wilkes satellite, 13 (15). The $^{18}O/^{16}O$ data are consistent enough and the variations in values large enough to support the suggestion that mean annual rates of accumulation in West Antarctica may have been underestimated. New-fallen snow at Ellsworth station showed the usual direct variation in δ^3 of the $^{18}O/^{16}O$ ratio with temperature over an impressively large range. Samples taken within individual snowfalls displayed different δ/temperature relationships depending upon the nature and history of the air masses involved. Samples of the wind-drifted snow from Little America V have a seasonal flavor, but their δ values are considerably lower than those of snow from a nearby pit. A speculative explanation of this anomaly is that some of the wind-driven snow comes from inland sources, possibly as much as 500 km away. Since this low-δ material does not seem to accumulate permanently at Little America V, consideration must be given to the alternative explanation that wind action produces mechanical separation favoring accumulation of ice particles with higher δ values. The low δ material may end up in the ocean. Quantitative relationships between variations in δ and surface air temperature, upper-air temperature, and tropospheric temperature are not overly impressive. Lack of consistency in the δ/surface-air temperature relationship can be attributed to the strong inversion frequently prevailing in Antarctica, but even the influence of upper-air and tropospheric temperatures appears to be variable. However, lower temperatures at any level are always associated with more negative δ values. This suggests that factors other than temperature are involved such as the previous history of the air mass, the length of overland travel, and the height to which the air has had to ascent. For example, the more negative mean δ value at Ellsworth station compared to Little America V may be partly due to the fact that some of the air masses reaching Ellsworth station crossed the polar plateau. Estimates based on the δ/temperature relationships suggest that material at a depth of about 290 meters at Byrd station accumulated under temperature conditions 2–4°C colder than now prevailing. (auth)

612 BONDING OF HYDROGEN IN HYDROGEN-MONTMORILLONITE. I. Th. Rosenqvist and Per Joergensen (Universitet Blindern, Oslo). Nature, 204: 176-7 (Oct. 10, 1964).

In order to elucidate the bonding problem of the protons of hydrogen micas, very pure dioctahedral montmorillonite from Skyrvedalen was examined. The desired hydrogen-

substituted minerals were obtained by introduction of NH_4^+ in the exchangeable positions and subsequent dissociation of NH_3 by heat treatment. It was concluded that the protons of hydrogen montmorillonite in the anhydrous state form OH partly with the basal O's and partly migrate towards apical O's forming OH's in the vacant octahedrons. The basal OH's are able to dissociate, entering ion exchange reactions, whereas the extra apical (octahedral) OH's are not exchangeable. Dioctahedral hydrogen montmorillonites consequently seem to form structures corresponding to those previously reported for dioctahedral hydrous micas, namely, mixed crystals between $KAl_3Si_3O_{10}(OH)_2$ and $H_2OAl_3Si_3O_3(OH)_3$. (P.C.H.)

613 FOURTEENTH VOYAGE OF THE SCIENTIFIC-RESEARCH VESSEL "MIKHAIL LOMONOSOV" IN THE ATLANTIC OCEAN. S. S. Voyt. Okeanologiya, 4: 536-40 (1964).

The research ship "Mikhail Lomonosov" left Sevastopol on August 11, 1963, on a 16,000-mile voyage. During this voyage 105 oceanographic stations were established, of which 15 were of the free-buoy type. In the tropical zone of the Atlantic Ocean, research was conducted according to an international program of oceanographic research (hydrography, meteorology, hydrochemistry, and hydrobiology). Subsequently, the "Lomonosov" investigated hydrophysical and meteorological problems of prime interest (physical structure of the ocean, currents and countercurrents, oceanic temperature inversions, solar radiation, wind velocity and direction, and atmospheric humidity). Throughout the voyage a continuous study was made of the radioactive contamination of water and of the surface layer of the atmosphere. Data on the concentration and density of beta-particle fallout and the results of gamma-spectrometric studies were used to determine the latitudinal distribution of radioactivity in the lower layers of the stmosphere. Other investigations included studies of water transparency and the ocean floor (topography, geologic composition, and structure). In the Brazilian basin the "Lomonosov" discovered two uncharted ridges with a relative relief of 2000 m. Rocks of basic volcanic origin were also found in that basin. (OTS)

614 STRONTIUM CONTENT AND VARIABLE STRONTIUM–CHLORINITY RELATIONSHIP OF SARGASSO SEA WATER. Fred T. Mackenzie (Bermuda Biological Station for Research, St. George's West, Bermuda). Science, 146: 517-18(Oct. 23, 1964).

Sargasso Sea water has a variable strontium-chlorinity relationship. This observation is contrary to the view that strontium in the ocean is in constant proportion to chlorinity. It is suggested that the increase in strontium concentration at 500 to 800 meters in Sargasso Sea water results from interaction between organic aggregates and the water. (auth)

615 ISOTOPE DETERMINATION AS AN AID TO PALEONTOLOGICAL RESEARCH. Erich Bagge (Universitat, Kiel). Strahlentherapie, Sonderbaende, 49: 1-5(1962). (In German)

The frequency occurrence of various isotopes is reviewed. Methods for increasing the accuracy for measurements of isotope frequency are discussed. Age estimation by radiocarbon dating is described. Determination of paleotemperatures by the relative frequency of oxygen isotopes is discussed. (M.C.G.)

Natural Radioactivity and Fallout

Refer also to abstracts 24 and 695.

616 (CONF-765-1) FALLOUT MEASUREMENTS BY TOTAL ABSORPTION GAMMA RAY SPECTROSCOPY. Robert S. Foote (Texas Instruments, Inc., Dallas). Oct. 6, 1964. Contract AT(40-1)-3147. 25p. Dep.(mn); $1.00(cy), 1(mn) OTS.

From 2nd Conference on Radioactive Fallout from Nuclear Weapons Tests, Germantown, Md., Nov. 1964.

Results are reported of field gamma radiation measurements made near Dallas, Texas, from Dec. 22, 1962, to June 30, 1964. The calibration of the gamma spectra and the errors are discussed in detail. The modulation of the fallout by rainfall is considered. Day results are presented for the following radioisotopes: ^{144}Pr, ^{140}La, ^{54}Mn, ^{95}Zr–^{95}Nb, and ^{137}Cs. The replacement of the matrix reduction method by the "least squares" method is considered briefly. (D.L.C.)

617 (CONF-765-3) LONG-RANGE FALLOUT FROM SEDAN AND SMALL BOY. Philip W. Krey and Ralph E. Fried (Isotopes, Inc., Westwood, N. Y.). Oct. 8, 1964. Contract AT(30-1)-3055. 33p. Dep.(mn); $2.00(cy), 1(mn) OTS.

From 2nd Conference on Radioactive Fallout from Nuclear Weapons Tests, Germantown, Md., Nov. 1964.

A sampling network was established across the United States to collect debris from the Sedan and Small Boy shots. Gross gamma assays, gamma decay measurements, gamma spectrum analyses, and radiochemical analyses were performed on retrieved samples. Sedan which was an underground burst produced a cloud which was fairly homogeneous and highly fractionated. Small Boy, a surface burst, gave a heterogeneous cloud and even greater fractionation effects than Sedan. MO-99 at both shots behaved as a refractory material and did not represent an ideal tracer of fission product debris. (auth)

618 (EUR-1820.d,f,i,n) RESULTS OF THE RADIOACTIVITY MEASUREMENTS IN THE COMMUNITY COUNTRIES. (European Atomic Energy Community). 1964. 120p. Dep.(mn).

Text appears in German, French, Italian, and Dutch.

Results are reported from measurements of fallout radioactivity at sampling stations located throughout Germany, France, Belgium, The Netherlands, Luxemburg, and Italy during 1963. Comparative data for the period from 1958 through 1963 are included. Samples of air and surface waters were analyzed for total radioactivity and ^{90}Sr, ^{89}Sr, ^{137}Cs, ^{144}Ce, and ^{106}Ru. (C.H.)

619 (HNS-50) Sr^{90} CONCENTRATION IN CONVECTIVE SHOWER PRECIPITATION, SPRING 1963. Progress Report. Paul Kruger, Larry G. Davis, and Charles L. Hosler (Hazleton-Nuclear Science Corp., Palo Alto, Calif.). June 30, 1964. Contract AT(04-3)-457. 54p. Dep.(mn); $3.00(cy), 2(mn) OTS.

Strontium-90 deposition rates in precipitation from convective showers sampled during the Spring of 1963 at State College, Pennsylvania, were examined and compared to the data obtained during the two previous years. Over this three-year period, the ^{90}Sr deposition data were consistently in accord with the complicated nature of the thunderstorm. The ^{90}Sr concentrations showed large concentration changes in short time periods in conjunction with the changing structure of convective activity. The peak ^{90}Sr concentrations occurred following the period of peak cloud development, as observed by radar echoes. The relative value of the peak concentration was influenced by the height of the cloud tops with respect to the tropopause and the clouds location with respect to jet streams. The relative value of the total deposition and the age of fission products in showers were also seen to be related to the pertinent history of nuclear weapons testing in the atmosphere. The ^{90}Sr concentrations for the 1961 showers were low after the three years of testing moratorium, the 1962 showers contained the 1961 and early 1962 debris, while the 1963 showers contained mostly the late 1962 debris. (auth)

620 (HW-81746(p.3.51-5)) FALLOUT STUDIES. R. W. Perkins (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

By use of multidimensional gamma-spectrometric counting techniques it was possible to make direct measurements of eleven fallout radionuclides on air filters. The observed concentrations of ^{22}Na, ^{54}Mn, ^{60}Co, ^{88}Y,

^{95}Zr–^{95}Nb, ^{106}Ru, ^{124}Sb, ^{125}Sb, ^{134}Cs, ^{137}Cs, and ^{144}Ce are reported and the significance of their relative concentrations is discussed. (auth)

621 (HW-81746(p.3.81-3)) SEDIMENT STUDIES: PARTICLE SIZE SEPARATION OF BOTTOM SEDIMENTS FROM THE McNARY RESERVOIR OF THE COLUMBIA RIVER. J. L. Nelson and L. L. Humphreys (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

A wet sieving particle sizing technique was used to size bottom sediments from the McNary Dam reservoir. The radionuclide contents of the size fractions are reported. (auth)

622 (HW-81746(p.3.84-6)) SEDIMENT STUDIES: ISOLATION OF ORGANIC MATERIAL FROM SUSPENDED COLUMBIA RIVER PARTICLES. L. L. Humphreys (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

A density-gradient method was applied to the separation of organic material from suspended Columbia River particles. Extent of separation was determined by "chlorophyll A" extractions, and differences in the adsorption of ^{60}Co, ^{65}Zn, ^{46}Sc, and ^{51}Cr onto inorganic and organic material were determined by gamma spectroscopy. (auth)

623 (HW-SA-3689) WHOLE-BODY COUNTING STUDIES OF Cs-137 IN ALASKAN ESKIMOS. H. E. Palmer B. I. Griffin, D. M. Fleming, and L. A. Braby (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Sept. 18, 1964. Contract AT(45-1)-1350. 12p. (CONF-747-2). Dep.(mn); $1.00(cy), 1(mn) OTS.

From 4th Symposium on Radioactivity in Scandinavia, Riso, Denmark, Oct. 1964.

Data are presented on the content of ^{137}Cs in Alaskan Eskimos as determined by whole-body counting from July 1962 through August 1964. The data show a continued increase in the ^{137}Cs body burdens during this time. Residents of Anaktuvuk Pass showed the largest increase with an average of 1280 nCi in July 1964, which is 206% higher than the average in the summer of 1962 and 104% higher than in 1963. The possible relation to the content of caribou in the diet to ^{137}Cs content in man is discussed. (C.H.)

624 (IDO-12035) CONTROLLED ENVIRONMENTAL RADIOIODINE TESTS AT THE NATIONAL REACTOR TESTING STATION. C. A. Hawley, Jr., C. W. Sill, G. L. Voelz (Idaho Operations Office. Health and Safety Div., AEC), and N. F. Islitzer (Weather Bureau, Idaho Falls, Idaho). June 1964. 73p. Dep.; $3.00(cy), 2(mn) OTS.

The CERT project consists of a series of planned releases of radioiodine over different vegetation and during various meteorological conditions, with the prime objective being to measure the amounts of radioiodine through the air-vegetation-cow-milk-human chain. Results are reported from a preliminary experiment at the National Reactor Testing Station (NRTS) in southeast Idaho that consisted basically of releasing radioiodine (iodine-131) gas over a natural Crested Wheatgrass pasture and using the contaminated grass for milk cow grazing. The resultant radioactive milk was fed to seven human volunteers. It was desired from this experiment to determine if the experimental design would establish, under known natural release conditions, the basic relationships between the amount of radioiodine in the air to that on the soil and vegetation, the amount of radioiodine on the vegetation to that in the milk, and the quantity in the milk to that in the human thyroid after drinking the milk. A total of 970 millicuries of iodine-131 gas was released at 1500 MST on May 27, 1963, near ground level over a 30-minute period under moderately unstable meteorological conditions and an average wind speed of 6.6 meters per second. About 13 percent of the total released iodine was deposited on the sampling grid, with 1.5 percent being actually on grass. The Crested Wheatgrass covered about 15 percent of the total plot, the remaining surface being soil. Deposition velocities ranged from 0.4 to 0.8 cm/sec with an average of 0.6 cm/sec. The activity on carbon fallout plates was found to be proportional to the grass measurements. Controlled grazing, which consisted of daily changes of 2×10^3 m^2 crosswind grazing strips, progressed from 300 meters downwind, toward the source, permitting quantitative measurement of grass consumption and activity. The effective half-life on grass was found to be about 3.5 days. The effective cow consumption measurement, which represents the accumulation of activity within the cow from the current and previous days' grazing, based on a one day half-life retention factor, and the measured activity in the milk showed good correlation. The ratio of activities of milk and grass (pCi/l : pCi/g) was 240 ± 35. The average human thyroid uptake of ingested iodine-131 in milk was 19 percent. A model to predict thyroid activity levels was developed and shown to be accurate. Thyroid doses to the volunteers averaged 0.39 rad. The preliminary experiment showed that the basic experimental procedures were adequate. Further tests in the series will employ the same general procedures in investigating the behavior of radioiodine under various meteorological and physical conditions. (auth)

625 (LAMS-2878) STRONTIUM-90, CESIUM-137, AND RADIOACTIVE RARE EARTHS IN ENVIRONMENTAL RAIN AND AIR AT LOS ALAMOS, NEW MEXICO, 1958–JUNE 1963. E. R. Graham (Los Alamos Scientific Lab., N. Mex.). July 15, 1964. Contract W-7405-eng-36. 17p. Dep.; $1.00(cy), 1(mn) OTS.

A study was made of the strontium-90, cesium-137, and the radioactive rare earths in environmental rain and air at Los Alamos, New Mexico. Samples of rain and air were collected continuously from January 1958 through June 1963. The results of the study showed the activity of the strontium-90 to be the highest during the summer of 1958; the activity then decreased slowly reaching the lowest level during September of 1961. Starting in October 1961 the activity started to rise, however, never reaching the level of 1958. The observed results of the environmental concentration of cesium-137 and rare earth radioactivity were similar to those for strontium-90. The results of the activity measured in the air and that in the rain followed the same monthly distribution. The results of the study indicate that the rain-held activity is just a wash out of the activity present in the Los Alamos air. (auth)

626 (NP-14380) PROGRESS REPORT FOR 1963—DEPARTMENT FOR RADIATION PROTECTION AND INSTRUMENTATION. (Aktiebolaget Atomenergi, Stockholm). 59p. (S-325). Dep.(mn).

Data are presented on radioactivity due to fallout in samples of air, precipitation, surface water, and milk collected in Sweden during 1963. The data are compared with similar data collected since 1958. Summaries are included of work in progress in the fields of reactor development, radiobiology, development of safety regulations, operation of a whole-body γ counter, waste disposal, development and calibration of radiation detectors, analytical chemistry services, and development of a technical library. Lists are included of reports written during 1963 that contain results of all experimental work. (C.H.)

627 (NYO-10533) LONG-RANGE FALLOUT FROM SEDAN AND SMALL BOY. Philip W. Krey, Ralph E. Fried, A. Bruce Caridi, Fernando Bazan, and Raymond J. Lagomarsino (Isotopes, Inc., Westwood, N. J.). June 15, 1964. Contract AT(30-1)-3055. 180p. Dep.(mn); $5.00 (cy), 4(mn) OTS.

In order to characterize fallout at remote locations from the Sedan and Small Boy tests, air-filter and passive fallout collector equipment was placed along three arcs at down-wind distances of 600, 1000, and 1400 miles from ground zero. The location of the equipment on the closest arc was deployed in accordance with post-shot meterological data to intercept the cloud. First order Weather Bureau Stations were employed as fixed sites on the more distant arcs. Results of sample analysis indicated debris from both tests to be highly fractionated. (auth)

628 (PNE-241F) IODINE INHALATION STUDY FOR PROJECT SEDAN, JULY 6, 1962. (Southwestern

Radiological Health Lab., Las Vegas, Nev.). May 20, 1964. 60p. Dep.; $3.00(cy), 1(mn) OTS.

Beagle dogs and currently accepted physical air-sampling equipment were exposed to the cloud produced by a nuclear cratering experiment to determine the deposition of ^{131}I in organs of the biological sampler with that collected by the physical sampling devices. Primary emphasis is directed to the evaluation of such factors as isotopic ratios, rate of build-up, and the effect of the thyroid gland in concentrating iodine. The results, which indicated the selectivity of the biological sampler and the inefficiency of the physical samplers, are discussed. (auth)

629 (TID-7696(p.101-10)) FIELD SPECTROMETRY OF ENVIRONMENTAL GAMMA RADIATION. Wayne M. Lowder, Harold L. Beck, and William J. Condon (New York Operations Office. Health and Safety Lab., AEC).

Spectrometric data on γ activity of soil samples collected at over 200 locations in New England and part of the western U. S. during 1962 and 1963 are summarized. The data show that typical surficial soil contents of natural radioactivity in the United States are 1.5% K, 1 ppm U, and 8 ppm Th, assuming equilibrium with their daughters in the cases of U and Th. Thus, K and Th contribute about equally to a typical gamma measurement (~3 μr/hr each), while U contributes about 1 μr/hr at nearly all locations. The unexpectedly small contribution of ^{226}Ra daughters to the total natural gamma field is probably due to the combined effects of the leaching of U and Ra from the upper layers of the soil and the escape of ^{222}Rn into the atmosphere. Fallout gamma measurements in the United States generally ranged from 1 to 4 μr/hr during 1962 and from 2 to 6 μr/hr during 1963, with considerable geographical and time variation noted. The primary contributor to fallout gamma dose rates during 1962 and 1963 was $^{95}Zr-^{95}Nb$, which almost invariably provided 65 to 80% of the total fallout gamma dose rate. Until September, the dose rate from $^{95}Zr-^{95}Nb$ inferred from the peak counts amounted to nearly 5 μr/hr. These and other results point up the significance of the relatively short-lived gamma emitters in the total exposure of the general population to man-made sources of radiation. (C.H.)

630 (TID-21206) SPONTANEOUS FISSION XENON IN NATURAL GASES. G. J. Wasserburg and E. Mazor (California Inst. of Tech., Pasadena. Charles Arms Lab. of Geological Sciences). [1963]. Contract AT(04-3)-41. 36p. Dep.(mn); $2.00(cy), 1(mn) OTS.

Isotopic enrichments of ^{132}Xe, ^{134}Xe, and ^{136}Xe were found in a number of natural gases and are attributed to the spontaneous fission of ^{238}U. The ratio of spontaneous fission xenon to atmospheric xenon and the ratio of spontaneous fission xenon to He are discussed in terms of a solubility model. It is shown that the isotopic enrichments can be explained in terms of a solubility model and a preferential release of He as compared to Xe_{SF} by up to a factor of 3. An estimate is made of the present flux of spontaneous fission xenon into the atmosphere. (auth)

631 (TID-21241) RADIOACTIVE ZINC-65 IN MARINE ORGANISMS IN FISHER'S ISLAND SOUND AND ITS ESTUARIES. Supplement to Final Report. Donald M. Skauen (Connecticut. Univ., Storrs and Connecticut. Univ., Noank. Marine Research Lab.). Oct. 12, 1964. Contract AT(30-1)-2487. 11p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Data are reported from measurements of the ^{65}Zn content in oysters in the Thames River, Conn., during the first half of 1964. Scintillation spectrometry techniques were used for the measurements. Results indicate that oysters serve as an excellent organism for monitoring ^{65}Zn in marine waters. (C.H.)

632 (TID-21279) ENVIRONMENTAL RADIOACTIVITY AT ARGONNE NATIONAL LABORATORY, JANUARY–JUNE 1964. (Argonne National Lab., Ill.). Contract [W-31-109-eng-38]. 25p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Data are presented on the level of radioactivity in the environment and on the amounts of radioactive materials, if any, added to the environment as a result of operations at Argonne National Laboratory. The radioactivity of the environment was determined on a continuing basis by measuring the radioactivity in naturally-occurring materials collected at selected locations both on and off the Argonne site. Air filter samples were collected continuously at seven locations on the Argonne site and at five locations off the site. The total alpha and beta activities are summarized. (auth)

633 (JPRS-25966(p.20-27)) STRONTIUM-90 IN THE SURFACE WATERS OF THE INDIAN OCEAN IN 1960–1961. N. I. Popov, V. M. Orlov, S. A. Patin, and N. P. Ushakova. Translated from Okeanologiya, 4: 418-22(1964).

The ^{90}Sr content in surface waters of the Indian Ocean was measured during 1960 and 1961. Sampling procedures and analytical methods used are described. Data are included on the radioactivity of air samples above the Indian Ocean during the period preceding the measurements. No marked variations in ^{90}Sr content was found in water samples collected from 20° North Latitude to 40° South Latitude. The effects of interchange of waters of the equitorial region of the Indian Ocean with waters of its other regions and the contribution of fallout in torrential rains of the equitorial region are discussed. (C.H.)

634 (JPRS-25966(p.42-52)) RADIATION CONDITIONS IN THE FISHERY REGIONS OF THE NORTH ATLANTIC (JUNE–AUGUST 1961). A. F. Fedorov, V. N. Podymakhin, V. P. Kilezhenko, N. I. Buyanov, and E. M. Goloskova. Translated from Okeanologiya, 4: 431-6(1964).

Results are reported from a survey of radioactivity in North Atlantic fishery regions during June, July, and August, 1964. Forty-four sampling stations were maintained in the vicinity of the Faroe Islands, Shetland Islands, Jan Mayen Island, and Bear Island. Data are presented from measurements of the ^{90}Sr content of sea water, the aggregate β activity of sea water, γ activity of the atmosphere over the ocean waters, the energy spectrum of γ radiation of the sea water, and the radioactivity of various organs and tissues of the chief commercial fish of the North Atlantic Ocean. (C.H.)

635 CHANGES IN THE ISOTOPIC COMPOSITION OF LEAD FROM DEPOSITS OF A NUMBER OF REGIONS. K. K. Zhirov. Dokl. Akad. Nauk SSSR, 158: 126-9(Sept. 1, 1964). (In Russian)

The $^{207}Pb/^{204}Pb$ ratio was plotted against the $^{206}Pb/^{204}Pb$ ratio for twelve large lead deposits in Central Kazakhstan. These deposits belong to geologically different types and are separated by hundreds of kilometers. With the use of the method of R. D. Russell reported in Lead Isotopes In Geology, London, 1960, it was found that the age of the deposits was close to 300×10^6 years within a 95% confidence limit. It was concluded that the larger lead deposits in Central Kazakhstan have a single genetic origin or are normal in isotopic composition. Lead deposits in the Caucasus indicate that the primary age of the Pb is 5.4×10^9 years, while the geological age is about 10^8 years. Contamination by Pb isotopes is probable. The Ural deposits also seem to have been contaminated with lead from older ores. The linear plot of the lead isotope ratios obtained with Morocco ores indicate that these ores belong to the Tertiary era. (TTT)

636 AMBIENT RADIOACTIVITY. STATION: MONCLOA (MADRID). Energia Nucl. (Madrid), 8: Suppl. A, No. 30, 13(Apr.–June 1964). (In Spanish)

The total β activity of the air and rain water measured daily at the Moncloa Station in Madrid in April 1964 is reported. (J.S.R.)

637 RADIOLOGICAL HEALTH DATA [MONTHLY REPORT], VOLUME V, NUMBER 9. (Public Health Service, Washington, D. C.). Sept. 1964. 47p. $0.50(GPO).

Data are presented on the radioactivity due to fallout fission products in samples of air collected throughout North and Pan America during May 1964, samples of milk collected throughout the U. S. and Canada during May 1964, and samples of surface waters and drinking waters collected throughout the U. S. during March 1964. Data are

included on the average per person dietary consumption and ^{90}Sr intake of individuals living in New York, San Francisco, and Chicago during Nov. and Dec. 1963, and the environmental radioactivity during 1963 at Atomics International, Canoga Park, Calif., National Reactor Testing Station, Idaho Falls, Idaho, and the Pinellas Peninsula Plant, St. Petersburg, Fla. Three underground nuclear tests at the Nevada Test Site during August 1964 were announced. Separate abstracts were prepared for two sections of this report. (C.H.)

For abstracts of individual papers see: 638 and 639.

638 CESIUM-137 IN TRI-CITY DIETS, OCTOBER–DECEMBER 1962. Joseph Rivera and John J. Kelly. Radiol. Health Data, 5: 434-6(Sept. 1964).

Data are reoorted on the ^{137}Cs content in the average diet of persons residing in New York City, Chicago, and San Francisco during the fourth quarter of 1963. The data are compared with similar data for the same period during 1962. (C.H.)

639 SUMMARY OF STATE RADIOLOGICAL ENVIRONMENTAL SURVEILLANCE ACTIVITIES. Carnick A. Markarian, George W. Williams, and Guntis Ozolins. Radiol. Health Data, 5: 447-50(Sept. 1964).

The status of State radiological environmental surveillance activities is reviewed. There are differences between states as to type and extent of analyses performed by the health departments for different environmental radiation vectors. A fundamental concern is that of producing reliable measurements and this is implemented through participation in quality control studies. (C.H.)

640 RADIOACTIVE CONTAMINATION OF ANIMAL FOOD PRODUCTS. A. Feteanu and I. Baditoiu. Rev. Sanit. Mil., 60: 423-30(May-June 1964).

Work done in various countries with regard to the radioactive contamination of foods originating from land animals and fish is reviewed. Studies are emphasized relating to the more dangerous isotopes, namely ^{89}Sr, ^{90}Sr, ^{131}I, and ^{137}Cs. A brief section of the paper relates research of this type in Rumania. Contamination of milk in Rumania did not increase in 1962 as against 1959. (OTS)

641 INVESTIGATION OF A PARTICLE PRODUCED IN AN ATOM BOMB EXPLOSION. Albert Sittkus (Max-Planck-Institut für Kernphysik, Heidelberg). Z. Naturforsch., 19a: 991-9(July-Aug. 1964). (In German)

In the radioactive aerosol of atmospheric air, a hot fission product particle on 10 μ diameter was found. From measurements of ^{95}Zr–^{95}Nb activity, it was determined that the particle originated on Dec. 19, 1962 (±1 day). Gamma-ray analysis showed an initial content of 11.2×10^8 ^{95}Zr, 1.2×10^8 ^{140}Ba, 2.4×10^8 ^{141}Ce, and 6.4×10^8 ^{144}Ce atoms. Microprobe measurements on 3 fragments showed that the principal mass of the particle consisted of iron and aluminum oxide (approximately 2×10^{13} Fe and Al atoms). With the help of the fireball model, estimations were made on the origin, composition, strength, and type of explosion produced. The particle, according to the evaluation, came from a 100 to 300 kt bomb with ^{239}Pu as the fissionable material. (tr-auth)

Site Survey and Selection

642 (NAA-SR-9982) AISITE II — A DIGITAL COMPUTER PROGRAM FOR INVESTIGATION OF REACTOR SITING. R. A. Blaine and E. L. Bramblett (Atomics International, Div. of North American Aviation, Inc., Canoga Park, Calif.). Oct. 15, 1964. Contract AT(11-1)-Gen-8. Dep.; $3.00(cy), 2(mn) OTS.

AISITE II is a reactor siting code written to provide a tool for parametric investigation of reactor siting. The present code is largely based on methods proposed by the Atomic Energy Commission but differs in certain of the assumptions and models. In particular, the present work extends the kinds of problems that can be investigated. The code automatically varies any one of 46 parameters such as reactor power, building leak rate, iodine cleanup rate, halogen filter efficiency, etc. The siting criteria of 10CFR100 are used in AISITE II with computation of the exclusion area, low-population boundary zone, and low-population-center distances as functions of any parameter. In addition, dose versus distance curves are obtained for inhalation, direct-building, and direct-cloud doses. The printed edit consists of the dose versus distance data, fractional contribution by isotope group to the inhalation dose, and critical distances for both a 2-hr and a 30-day release. Graphical displays (SC-4020) can be obtained for critical distances as a function of the variable parameter and dose versus distance for any organ or the critical organ, for each value of the parameter. In addition to added flexibility, AISITE II has a model for determining gross fission products and provides three isotope release models with up to four levels of containment. The running time was reduced by a programming feature that determines whether the variable parameter effects a given portion of the calculation and omits that portion if unchanged. Other features of the code include built-in libraries of isotope decay constants, average gamma energies, yields, absorption coefficients in air, mass of organs, and others. Addressable data are used so that multiple cases can be run where only changes are specified. Programming is modular so that models are easily replaced when necessary. The code was written in FORTRAN II and operates on the NAA-FIB III or IBM monitor system for IBM 7094. For AISITE, see NSA 18: 12368. (auth)

Techniques and Equipment

643 (DASA-1484) CHARACTERISTIC EMISSIONS FROM AN UNDERGROUND EXPLOSION. Computational Technique and Results. Vincent Cushing, William Losaw, and Dean Reily (Engineering Physics Co., Rockville, Md.). Feb. 15, 1964. Contract DA-49-146-XZ-089. 57p. (AD-441249)

The basic partial differential equations describing the spherical propagation of explosively generated mechanical and thermodynamic disturbances are reviewed. A FORTRAN computer program, utilizing a numerical method of Lax, is presented, which calculates, from the equations of conservation of mass and momentum, the density-time and particle velocity-time profiles generated by the propagation of a disturbance whose history is known at a fixed radius. Attention is given to various equations of state, including those where the pressure is dependent both nonlinearly and linearly on the density. Computational results are presented that include a comparison of the numerical solution of a problem to its analytical solution. (auth)

644 (HW-81746(p.3.97-8)) DETERMINATION OF SUBTERRANEAN WATER FLOW RATES BY MEASUREMENT OF THE I^{133} TO I^{131} RATIO. D. E. Robertson and R. W. Perkins (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Radioactive tracers were found to be a useful tool in hydrological studies. The usefulness of radioiodine ^{131}I and ^{133}I was demonstrated in underground water flow rate measurements. (auth)

645 (HW-81746(p.4.24-7)) ELECTRICAL ANALOG SIMULATION OF THE HANFORD GROUND-WATER FLOW SYSTEM. J. R. Raymond (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Equipment, techniques, and methods were tested to evaluate the feasibility of ground-water flow simulation by a large electrical analog model. Resistance test networks were constructed to evaluate assembly methods, components, and theoretical considerations and to compare analog digital techniques. Operational experience with the test models allowed evaluation of cost, component applicability, and assembly time involved in constructing a full scale project analog. Although design and construction of a large (10,000 to 14,000 node) project analog are considered feasible, numerical solution of the ground-water flow system by

digital computer techniques appeared more flexible and less costly. (auth)

646 (HW-81746(p.4.28-32)) A PRACTICABLE METHOD FOR MEASURING FLUID POTENTIALS AND MONITORING GROUND WATER CONTAMINATION IN VARIOUS AQUIFERS. D. J. Brown (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

A Hanford-developed computer program was used to relate hydraulic potential distributions in sand-filled wells with those in wells that have cemented sections. The results showed that wells filled with sand yield measurements that more nearly duplicate actual conditions in the field. Piezometer tubes installed in deep wells by the sand-pack method provided reliable structures for obtaining representative samples of the ground water with depth and for obtaining measurements of the ground water distribution in the various aquifers. (auth)

647 (HW-81746(p.4.61-3)) GEOPHYSICAL SEISMIC SURVEY STUDY. R. E. Brown and J. R. Raymond (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

A test program demonstrated the applicability and advantages in the use of geophysical seismic methods in procurement of geological data important in defining ground-water flow paths. Characteristics of the post-basalt sediments were readily determinable and significant units were traceable. Features below the topmost basalt flow were not identifiable or traceable with techniques tested. It was concluded that refraction seismic methods (using surface shooting with fertilizer-grade ammonium nitrate), rotary drilling, and inhole logging of wells for geologic control present a fast, definitive, and economical combination of shallow exploration techniques. (auth)

648 (SC-4741(RR)) MEASUREMENTS ON A SPHERICAL SHOCK WAVE IN A GRANITE MEDIUM. HARDHAT EVENT. Final Report. A. J. Chabai and R. C. Bass (Sandia Lab., Albuquerque, N. Mex.). Dec. 1963. Contract [AT(29-1)-789]. 105p. Dep.(mn); $4.00 (cy), 2(mn) OTS.

Measurements of peak shock pressure and shock wave arrival time were made on a spherical shock wave generated by a 5-kiloton explosion in granite. A simple and convenient procedure is presented for computing the quantities measured. Data are compared with results of calculations and also with four other theoretical predictions. (auth)

649 ON THE INTERPRETATION OF DISCORDANT AGE VALUES CALCULATED ACCORDING TO ISOTOPE RATIOS Pb^{206}/U^{238}/ AND Pb^{207}/U^{235}. Yu. A. Shukolyukov (Laboratory of Precambrian Geology, Leningrad). Geokhimiya, No. 9, 855-65(1964). (In Russian)

The crystal lattice of radioactive minerals is permeated with a network of microfissures, microchannels, and disturbances of various types. Atoms of radiogenic lead are present in the disturbances of the crystal structure. Lead and uranium migration is not caused by a volumetric diffusion but by a chemical interaction with solutions filling the disturbances of the crystal lattice. Series of cogenetic minerals in the coordinate system of $^{206}Pb/^{238}U$–$^{207}Pb/^{235}U$ may form straight (or nearly straight) lines. However the definition of the true age and the time of metamorphism by extrapolation of the lines before the intersection with the curve of coordinated values is permissible only in cases when the corresponding geochemical history of the samples has been proved by an independent method. (auth)

650 ON THE TASK OF A STATISTICAL STUDY OF GEOCHEMICAL PROCESSES DURING THE FORMATION OF MAGMATIC ROCKS. D. A. Rodionov (Inst. of Mineralogy, Geochemistry and Crystal Chemistry of Rare Elements, Academy of Sciences, USSR). Geokhimiya, No. 9, 945-53(1964). (In Russian)

Geochemical processes are considered as sequences of k-measured random vectors where k is passing through values from 1 to n (n is the number of states). The necessity of applying a multivariate statistical analysis in comparing various processes is shown. Errors are considered that arise in comparing final results instead of complete characteristics of the processes. (auth)

651 GAMMA-OPROBOVANIE URANOVYKH RUD V ESTESTVENNOM ZALEGANII. (Gamma Prospecting for Uranium Ores in Rock Deposits). V. M. Bondarev, V. G. Gubanov, P. K. Korovin, A. K. Ovchinnikov, and I. M. Khaikovich. Moscow, Publishing House "Natural Resources," 1964. 202p.

The theory, methods, and techniques for γ-radiation prospecting for uranium ores are described, and radiometric field equipment is discussed. (R.V.J.)

Thorium and Uranium Minerals

652 (CEA-R-2332) CONTRIBUTION AUX METHODES D'ESTIMATION DES GISEMENTS D'URANIUM. (Contribution to the Methods for Estimating Uranium Deposits). Aime Carlier (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Fontenay-aux-Roses). 1964. 410p. Dep.(mn).

Thesis submitted to Université, Paris.

After a definition of a deposit of economic value according to the marginal theory, several categories of ore reserves are discriminated according to the degree of knowledge of the deposit and according to the mining stage where the ore is considered. The conventional French classification of "on sight," "probable," and "possible" ore categories is dismissed and more suitable ones are suggested. The "sensu stricto" ore reserves are those for which the random error can be calculated. The notion of the natural contrast of grades in an ore deposit (absolute dispersion coefficient α) is introduced in relation to this topic. Three types of mining exploration are considered: The first is the random exploration so often met; the second is the logical exploration based on a systematic location of underground works, bore-holes, etc. The third, and hardest to achieve, is the one which minimizes exploration costs for a given level of accuracy. Sampling errors are discussed, such as those resulting from the quartering of a heap of ore (theory of Pierre GY) or those resulting from the use of radiometrical measurement of grade. The extension error (entailed by the assimilation of samples to the deposit they are issued from) is considered, and the essential formulas are given in order to appraise the random error (Geostatistics of Matheron). As to the estimator itself the work shows how the disharmony between the ore sample and the associated influence zone can be solved by the way of "kriging." Numerous examples are given of the various numerical parameters, characteristics of an uranium deposit (absolute dispersion coefficient) or of an uranium ore (liberation parameter) as well as a few examples of linear correlations between gamma radioactivity and uranium grade. Three complete examples of reserve evaluation are given. The notion of ruin risk which has to be taken in some cases is discussed. A detailed alphabetical index is given of the definitions, formulas or theories. (auth)

653 RAW MATERIALS FOR NUCLEAR ENERGY. H. G. Raggatt (Australian Atomic Energy Commission). At. Energy Australia, 7: No. 3, 2-6(July 1964).

The three metals that are most important as raw materials for atomic energy are U, Th, and Be. Geologic prospecting and ore deposits of the three metals in South Africa, Canada, Australia, and the U.S.A. are discussed. Future exploration is also discussed. (P.C.H.)

654 PRELIMINARY DATA ON DEEP CONSTITUENTS OF URANIFEROUS AND VANADIFEROUS ORES OF MOUNANA (GABON). Jacques Geffroy, Fabien Cesbron, and Paul Lafforgue. Compt. Rend., 259: 601-3(July 20, 1964). (In French)

Below the oxidized zone of green uranium vanadates, there is mineralogical dissociation between the two metals: the deep ore has pitchblende and coffinite in one section

and karelianite, montroseite, and rescoelite in the other section. In the intermediary zone, duttonite and corvusite appear to be precipitation products in reducing milieu. (tr-auth)

655 DETERMINING THE AGE OF MATSESTA MINERAL WATER FROM THE CONTENT OF RADIUM AND MESOTHORIUM-I. A. N. Pavlov. Dokl. Akad. Nauk SSSR, 158: 366-9(Sept. 11, 1964). (In Russian)

Analyses on the Matsesta mineral waters show that the concentration of Na^+, K^+, Ca^{2+}, Mg^{2+}, Cl^-, and HCO_3^- is gradually diluted to a depth of 300 m. The mineral concentration shows a sharp increase at a depth of 300 to 900 m. The sulfate concentration remains the same at 600 to 1500 m, and tends to zero below 1800 m. The concentration of radium in the Matsesta, hydrogen sulfide water is anomalously high. The analyses for sulfate, hydrogen sulfide, and radium as a function of temperature indicate that the radium is being carried in by extraneous water. In the region of Khosta, a sharp increase in the concentrations of Cl^-, Ca^{2+}, and HCO_3^- was observed at a depth of 1650 to 1800 m. A smaller increase in content of alkali metal ions was observed. The concentration of sulfate ion increases sharply with depth. The contents of radium and mesothorium I showed local anomalies. The absolute concentration of radium is very high, and can be considered anomalous for water from carbonate deposits. At a depth of 1830 to 2120 m, admixture of extraneous oil-bearing water is deduced from the chemical analyses. The content of mesothorium I in the Khosta water is not in equilibrium with its radium content, because of the precipitation of mesothorium I due to cooling of the water with subsequent decay of mesothorium I (half life = 6.7 years). (TTT)

656 CATION EXCHANGE PROPERTIES OF HUMIC ACIDS AND THEIR IMPORTANCE IN THE GEOCHEMICAL ENRICHMENT OF UO_2^{++} AND OTHER CATIONS. A. Szalay (Inst. of Nuclear Research, Hungarian Academy of Sciences, Debrecen). Geochim. Cosmochim. Acta, 28: 1605-14(Oct. 1964).

It was demonstrated that the cation-exchange capacity for UO_2^{++} has a maximum value in the peat state of 2-3 m-equiv/g. The cation-exchange capacity of lignites never exceeds about 0.7 m-equiv. The role of humic acids in the geochemical enrichment of other cations is more than a possibility, although it has not yet been sufficiently explored. A number of cations were studied and found to be sorbed and exchanged by humic acids. Similar observations were made by others. Inasmuch as the overwhelming majority of nuclear fission products can be sorbed, humic acid presents a very useful substance for waste disposal problems of the atomic energy industry. The enrichment constant is high for many other cations, and at least for some of them it is higher than for uranium; examples are Th^{4+}, rare earths, Zr^{4+}, etc. The enrichment constant, however, is not the sole factor for geochemical enrichment. The cation must be mobile in natural waters and soluble in the pH range of 4-7, which is favorable for sorption. This presents a bottleneck for study of geochemical enrichment, for to investigate the general role of humic acids in geochemistry the mobility of cations must first be studied. (P.C.H.)

657 BEHAVIOR OF U, Th, Nb AND Ta IN THE ALBITIZATION PROCESS OF GRANITOIDS OF THE OGNITSK COMPLEX (EASTERN SAYANY). V. I. Kovalenko, I. A. Krinberg, V. P. Mironov, and G. I. Selivanova (Inst. of Geochemistry, Irkutsk, Siberia SSR). Geokhimiya, No. 9, 886-92(1964). (In Russian)

On the basis of a study of U, Th, Nb, and Ta contents in albitization zones of leucocratic granites of the Ognitsk complex it is shown that the content of these elements in the rock depends on the alkalinity—acidity of the corresponding parageneses. With the alkalinity decrease an enrichment of rocks in U and Nb is observed and the rare metal mineralization with a low value of the Nb/Ta ratio is typical of albitization zones of granites with a heightened alkalinity. In the granite albitization U, Th, Nb, and Ta accumulate in the front metasomatose zones and leach out in a zone of the most distant background. (auth)

658 USE OF PHYSICO-CHEMICAL METHODS FOR EXPERIMENTAL DETERMINATION OF URANIUM MODE OF OCCURRENCES IN OXYGEN-CONTAINING UNDERGROUND WATERS. M. B. Serebriakova. Geokhimiya, No. 9, 926-36(1964). (In Russian)

For the determination of uranium mode of occurrences in oxygen-containing underground waters an investigation was carried out with the use of physico-chemical methods: ultrafiltration, dialysis, adsorption, on ion-exchange resins, and electrodialysis. The investigation showed that in these waters a colloid form of uranium is absent. Almost the total uranium (95–98%) is present in the form of a complex anion. (auth)

659 URANIUM AND THORIUM IN VARISCIAN ALKALINE INTRUSIONS MATCH AND TURPI (SOUTH TIENSHAN). L. L. Leonova (Vernadskii Inst. of Geochemistry and Analytical Chemistry, Moscow). Geokhimiya, No. 9, 956-9(1964). (In Russian)

Studies of the variscian Match syenite granite intrusions showed that the contents of U and Th in the first phase syenites are 0.3 γ/g and 2.1 γ/g, respectively; in the second phase, 1.6 γ/g and 5.2 γ/g; in the third, 9.1 γ/g and 31.2 γ/g. The nepheline syenites of Turpi contained 1.7 γ/g U and 9.4 γ/g Th; the alkaline syenites, 2.4 γ/g and 15.7 γ/g; and the granites, 8.2 γ/g and 38.7 γ/g. (R.V.J.)

660 URANIUM–LEAD ISOTOPIC VARIATIONS IN ZIRCONS: A CASE STUDY. Leon T. Silver and Sarah Deutsch (California Inst. of Tech., Pasadena). J. Geol., 71: 721-58(Nov. 1963).

Zircons in a single 250-pound block of Precambrian Johnny Lyon granodiorite from the Dragoon Quadrangle in Cochise County, Arizona, were concentrated with special attention to yield and nature of impurities. Morphology, zoning, color, inclusions, size distribution, radioactivity, refractive indexes, cell dimensions, and other properties were compared with the isotopic properties in the U–Pb system (and to a less precise degree in the Th–Pb system). It was observed that uranothorite impurities, while less than 1% in abundance, contribute much more than 50% of the activity in conventionally prepared concentrates. The presence of uranothorite drastically affects the apparent ages in the zircons. The uranothorite can be satisfactorily removed by an appropriate acid-washing procedure. The uranothorite-free zircon concentrates are not homogeneous and show systematic variations in radioactivity and various isotopic properties as a function of average crystal size. Individual zircons show internal variation in radioactivity and may differ in specific activity from other individuals by as much as an order of magnitude. It is possible to strip outer layers experimentally from an aggregate of zircons to determine variations in composite internal isotopic properties. The family of uranium–lead systems distinguished in the inhomogeneous zircon suite may be utilized to establish patterns of isotopic ratio variations that yield much more useful geochronological information than any single system. All systems in this rock appear to have formed 1,655 million years ago and to have been profoundly disturbed by an event 90 million years ago. There is no evidence of any type of disturbance other than this simple episodic pattern. While the mechanism of disturbance was not directly established, it is evident that radioactivity and radiation damage strongly influence susceptibility of the systems to disturbance. It is possible to offer reasonable explanations for some of the puzzling discrepancies between uranium–lead and thorium–lead ages determined on a single mineral concentrate. Recognition of the existence of families of uranium–lead systems among the variable members of a single mineral species, or in associated mineral species, in a single typical granitic rock provides a powerful tool for investigation of the processes and conditions that have influenced the age-dating systems. The systematic variations in U and Th provide interesting information on the role of some trace elements and accessory minerals in the crystallization history of the rock. The Johnny Lyon granodiorite is the oldest igneous rock dated in Arizona thus far and places a minimum age of 1,655 ± 20 million years on the orogeny called Mazatzal Revolution. (auth)

HEALTH AND SAFETY

Refer also to abstracts 613, 1093, 1203, and 1947.

661 (AECL-2043) ESTIMATION OF DOWNWIND CONCENTRATION OF AIRBORNE EFFLUENTS DISCHARGED IN THE NEIGHBOURHOOD OF BUILDINGS. P. J. Barry (Atomic Energy of Canada Ltd., Chalk River, Ont.). July 1964. 17p. Dep.; $0.50(AECL).

The air flow in the neighborhood of buildings is briefly described and compared with that assumed for the usual atmospheric diffusion equations. The literature is reviewed and empirical formulas which have been proposed are listed and compared. (auth)

662 (AECL-2050) ANALYSIS OF EXTERNAL RADIATION EXPOSURES IN 1963. G. Cowper and P. C. Rowe (Atomic Energy of Canada Ltd., Chalk River, Ont.). May 1964. 10p. Dep.; $0.50(AECL).

An analysis of occupational radiation exposures received by employees in 1963 was carried out by machine accounting methods. Results are presented in tables and graphs. (auth)

663 (AHSB(A)-R-8) PROCEEDINGS OF THE SYMPOSIUM ON THE TRANSPORT OF RADIOACTIVE MATERIALS, DURLEY HALL, BOURNEMOUTH, APRIL 13-15, 1964. F. J. Neary, ed. (United Kingdom Atomic Energy Authority. Authority Health and Safety Branch, London). Aug. 1964. 129p. Dep.; $3.40(BIS), 17s. 0d. (HMSO).

Separate abstracts were prepared on fourteen papers presented at this symposium. (C.H.)

For abstracts of individual papers see: 664, 665, 666, 667, 668, 669, 670, 671, 672, 673, 674, 675, 676, and 677.

664 (AHSB(A)-R-8(p.7-11)) THE TRANSPORT OF RADIOACTIVE MATERIALS. F. W. Spiers (United Kingdom Atomic Energy Authority. Authority Health and Safety Branch, London).

The early history of radiation protection and the basic premises underlying maximum permissible levels are reviewed. Regulations for the transport of radioactive materials are discussed. The role of the Transport Panel of the Radioactive Substances Advisory Committee in the coordination of regulations for the transport of radioactive materials in Great Britain is discussed. (C.H.)

665 (AHSB(A)-R-8(p.13-17)) INTRODUCTION TO RADIOACTIVITY AND ASSOCIATED HAZARDS WITH PARTICULAR REFERENCE TO TRANSPORT. (a) HEALTH PHYSICS ASPECTS. F. Morley (United Kingdom Atomic Energy Authority. Authority Health and Safety Branch. Radiological Protection Div., Harwell, Berks, England).

Hazards associated with the transport of radioactive materials are reviewed. It is pointed out that an adequately packed consignment of radioactive material can give rise to external radiation exposures only, and the degree of risk can be readily assessed by simple dose-rate measurements at or near the package surface. The risk of internal radiation exposure will arise only if there is spillage or leakage of radioactive material from a package as the result of an accident. Topics discussed include naturally occurring radioactivity, the unit of radioactivity, specific activity, artificially radioactive substances, radioisotopes, radioactive materials in bulk, radiation from radioactive substances, the detection and measurement of radiation, and sources of radiation exposure. (C.H.)

666 (AHSB(A)-R-8(p.19-24)) INTRODUCTION TO RADIOACTIVITY AND ASSOCIATED HAZARDS WITH PARTICULAR REFERENCE TO TRANSPORT. (b) MEDICAL ASPECTS. K. P. Duncan (United Kingdom Atomic Energy Authority. Authority Health and Safety Branch. Radiological Protection Div., Harwell, Berks, England).

The biological effects of radiation are reviewed that are relevant to exposures that may occur during the transport of radioactive materials. Emphasis is placed on early and late somatic effects of external radiation and of uptake into the body of radioactive materials. Permissible levels of exposure to radioactive materials are discussed. (C.H.)

667 (AHSB(A)-R-8(p.25-30)) ATOMIC ENERGY LEGISLATION IN THE UNITED KINGDOM WITH PARTICULAR REFERENCE TO TRANSPORT. I. G. K. Williams (United Kingdom Atomic Energy Authority. Authority Health and Safety Branch, London).

Legislation in the United Kingdom governing the transport of radioactive materials is reviewed. It is pointed out that many departments are involved in the administration of regulations and a balance between legal compulsion and voluntary acceptance of codes of practice based on consultation has been achieved. The legislation in effect is based on the regulations of the International Atomic Energy Agency. (C.H.)

668 (AHSB(A)-R-8(p.31-5)) THE NATURE AND EXTENT OF RADIOACTIVE TRAFFIC IN THE U.K. (a) ISOTOPES. R. West (United Kingdom Atomic Energy Authority. Authority Health and Safety Branch. Radiological Protection Div., Harwell, Berks, England).

The transport of radioactive materials in Great Britain has increased steadily during the past decade, particularly the shipment of radioisotopes for use in medicine, research, and industry. During 1963, 48,000 shipments of radioisotopes were made, with over 50% of the consignments sent overseas by air transport to 60 countries. Road transport is the transport method of next importance, accounting for 21% of consignments, with regular deliveries being made to users at hospitals, universities, and industrial companies. Rail transport on direct routes accounts for 11% of consignments and the remaining 14% of material is transported by normal postal service. Less than 1% of radioisotope shipments are made by sea transport. It is pointed out that radioisotopes are in effect perishable goods and their acceptance as normal articles of traffic is essential to their continued benefit to science and medicine. Since 1948 there have been few accidents during transport and no contamination has been released as the result of any such accident and the amount of external radiation to personnel has been small. (C.H.)

669 (AHSB(A)-R-8(p.37-45)) MOVEMENT OF FUEL AND OF FUEL MATERIALS. K. J. Norman (United Kingdom Atomic Energy Authority. Authority Health and Safety Branch, London).

Safety procedures used for the transport of nuclear fuels and fuel materials in Great Britain are discussed. The cycle of movement of materials between production sites and reactor sites is outlined. The use of rail and road transport is discussed. Natural uranium fuel elements are also supplied to British built reactors at Latina in Italy and Tokai Mura in Japan. The Latina fuel is shipped in rail wagons by the channel ferry and overland route to Italy and the fuel for Tokai Mura is shipped by regular cargo lines. (C.H.)

670 (AHSB(A)-R-8(p.47-51)) TRANSPORT REGULATIONS. (a) GENERAL PRINCIPLES UNDERLYING REGULATIONS GOVERNING THE TRANSPORT OF RADIOACTIVE MATERIALS. J. B. W. Armstrong (United Kingdom Atomic Energy Authority. Authority Health and Safety Branch, London).

Regulations of the International Atomic Energy Agency governing the transport of radioactive materials are reviewed. It is pointed out that regulations in Great Britain are based on these regulations. National regulations include formal legal regulations with penalties for infringement, and codes of practice. The broad objectives of the regulations include the control of external radiation exposure, the control of toxicity, criticality control, and the prevention of the generation of internal heat. (C.H.)

671 (AHSB(A)-R-8(p.53-8)) TRANSPORT REGULATIONS. (b) THE DEVELOPMENT OF INTERNATIONAL AND NATIONAL TRANSPORT REGULATIONS. R. Gibson (United Kingdom Atomic Energy Authority. Authority Health and Safety Branch, London).

The development of International and National regulations governing the transport of radioactive materials in Great Britain is reviewed. The Regulations of the International Atomic Energy Association were adopted in 1960. Before that time, regulations published in the Blue Book of United Kingdom shipping regulations were in force. (C.H.)

672 (AHSB(A)-R-8(p.59-62)) THE TRANSPORT OF FISSILE MATERIALS. J. T. Daniels (United Kingdom Atomic Energy Authority. Authority Health and Safety Branch, London).

Regulations governing the transport of fissionable materials in Great Britain are reviewed. Uranium-235 and ^{239}Pu are the materials most commonly shipped, although small amounts of ^{233}U and ^{241}Pu are also shipped. It is pointed out that criticality cannot occur with less than a certain minimum mass of fissile material and that the critical mass of material can be rendered safe by ensuring that neutrons do not form a divergent chain reaction. This can be achieved by placing the fissile atoms far enough apart or by introducing materials that absorb or capture neutrons. The packaging and handling of 3 classes of fissile materials are discussed. (C.H.)

673 (AHSB(A)-R-8(p.63-80)) APPROVAL OF PACKAGING DESIGN. A. Fairbairn (United Kingdom Atomic Energy Authority. Authority Health and Safety Branch, London).

Packaging designs for the shipment of radioactive materials are described in detail. Design principles are outlined and tests for packaging are described. Topics considered include shielding, containment, control of criticality, ability of packaging to withstand the transport environment, and certificate of approval. (C.H.)

674 (AHSB(A)-R-8(p.81-7)) LIABILITY AND INDEMNITY POLICY. B. C. Peatey (United Kingdom Atomic Energy Authority. Authority Health and Safety Branch, London).

Provisions for liability and indemnity for injury or damage caused during the transport of radioactive materials in Great Britain are reviewed. It is pointed out that the Nuclear Installations Licensing and Insurance Act of 1959 provides that anyone, other than the Atomic Energy Authority, who operates a reactor or processes or stores nuclear material must obtain a license from the Minister of Power and must maintain insurance against third-party liability, including materials in transit. The Atomic Energy Authority Act of 1954 provides that the Authority shall secure that no ionizing radiations from any of its premises shall cause hurt or property damage whether on the premises or elsewhere. (C.H.)

675 (AHSB(A)-R-8(p.89-108)) RADIATION AND OTHER RISKS. F. D. Sowby (United Kingdom Atomic Energy Authority. Authority Health and Safety Branch, London).

The hazards to human populations from radiation exposure are compared with those of other risks. The risks considered include cardiovascular diseases, malignant neoplasms, respiratory diseases, parasitic infections, metabolic diseases, and accidents, particularly traffic deaths. It is postulated that acceptable doses of radiation should be established only after the risks are balanced against the advantages of the exposure. (C.H.)

676 (AHSB(A)-R-8(p.109-12)) TRANSPORT ACCIDENTS: EMERGENCY ORGANISATION. F. J. Neary (United Kingdom Atomic Energy Authority. Authority Health and Safety Branch, London).

The transport environment presents a relatively restricted and predictable range of potential hazards for radioactive materials but demands a flexible emergency organization. The emergency handling of incidents involving radioactivity away from fixed sites in Great Britain is under the control of an interdepartmental working party known as the National Arrangements for Incidents Involving Radioactivity (NAIR). It is pointed out that since 1948 there have been no transport accidents resulting in the release of radioactivity and any increase in external radiation resulting from accidents during the transport of radioactive materials has been extremely small. (C.H.)

677 (AHSB(A)-R-8(p.113-21)) DEVELOPMENT OF RADIOLOGICAL PROTECTION STANDARDS— THE HISTORICAL PERSPECTIVE. Biran Windyer (Middlesex Hospital. Meyerstein Inst. of Radiotherapy, London).

Safety aspects of the uses of ionizing radiations are discussed and the development of radiological protection standards is reviewed. It is pointed out that the health and safety record of the atomic energy industry is extremely good. (C.H.)

678 (CEA-R-2488) INTERPRETATION DES EXPERIENCES DE CRITICITE SUR DES SOLUTIONS HOMOGENES DE PLUTONIUM ET D'URANIUM. (Interpretation of Criticality Experiments on Homogeneous Solutions of Plutonium and Uranium). Marie France Ithurralde, Jacques Kremser, Jean Leclerc, Christiane Lombard, Jean Moreau, and Claude Robin (France. Commissariat à l'Energie Atomique. Centre d'Études Nucléaires, Saclay). Aug. 1964. 38p. Dep.(mn); $2.00(cy), 1(mn) OTS.

Criticality experiments on solutions of fissionable materials were carried out in tanks of various geometries (cylinder, isolated annular cylinder, interacting annular cylinders); the reflection conditions were also varied (without reflection, semi-reflection and total reflection by water). The range of the concentrations studied is rather large (18.8 to 104 gms/liter). The interpretation of these experiments was undertaken in order to resolve the problems of the industrial use of homogeneous plutonium and uranium solutions. Several methods, the fields of application of which are different, were used: diffusion method, transport method, and Monte Carlo method. (auth)

679 (HNS-1229-54) A PROCEDURE FOR THE CALCULATION OF NEUTRON ACTIVATION OF AN INFINITE HOMOGENEOUS MEDIUM. C. L. Carnahan (Hazelton-Nuclear Science Corp., Palo Alto, Calif.). Sept. 15, 1964. Contract AT(29-2)-1229. 67p. Dep.(mn); $3.00(cy), 2(mn) OTS.

A method for the calculation of quantities of radionuclides induced in infinite, homogeneous media by neutrons from underground nuclear detonations is developed theoretically and a procedure for practical application of the theory is presented. Results of calculations are given for radionuclides, having half lives greater than 0.5 year, induced by neutrons from fusion reactions and from fission reactions in media having the compositions of the average earth's crust, average carbonate rocks, and the Tatum salt dome, Hattiesburg, Mississippi. Separate calculations are made for fusion neutrons and for fission neutrons because of the great differences in the initial neutron energy distributions and in the total numbers of neutrons produced, per unit energy yield, by the two processes. The following types of reactions are treated: (n,γ), (n,p), (n,α), (n,2n), and (n,np). Secondary reactions and second-order reactions are not considered. Effects due to activation of device and emplacement materials are not considered, and effects due to special neutron-moderating and absorbing materials placed around the device are considered only very superficially. A sample calculation is included. (auth)

680 (HW-67349) AN ANALYSIS OF THE REDOX CMP RADIATION VARIABLES. L. R. Wallis (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Nov. 7, 1960. Contract AT(45-1)-1350. 15p. Dep.(mn); $1.00(cy), 1(mn) OTS.

An investigation was conducted on the variables and parameters that affect dose rate measurement and control on the Redox crane maintenance platform. The variables studied include isotopic abundance in the contaminate, beta particle flux, scattered radiation, hot spots, and x-ray production by beta particles. It is concluded that a monitoring

procedure is needed which will distinguish between penetrating and non-penetrating radiation. (D.L.C.)

681 (HW-81746(p.2.29-31)) LOW-ENERGY FAST NEUTRONS. L. L. Nichols, W. C. Roesch, and J. G. Pengra (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

A study was begun to assess the importance of neutrons in the approximate energy range 0.1 to 1.0 Mev in health physics. (auth)

682 (HW-81746(p.3.25-8)) THE EFFECT OF SPOKANE RIVER SALTS ON HANFORD REACTOR EFFLUENT RADIOACTIVITY. W. B. Silker (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

The concentrations of various chemical elements in the Spokane River and the Columbia River at Hanford were measured during the first 6 months of 1963. The salt contributions from the Spokane River were correlated with changes in the concentrations of their respective neutron activation products in Hanford reactor effluent water. Good agreements obtained with arsenic, manganese, lanthanum, uranium, and zinc indicated the Spokane River was a significant source of these radionuclides. (auth)

683 (HW-81746(p.3.29-30)) THE EFFECT OF FILTER FLOW RATE ON REACTOR EFFLUENT RADIOACTIVITY. W. B. Silker and C. W. Thomas (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Radioisotopes present in Hanford effluent were compared for two filter flow rates from the water treatment pilot plant. The flow rates were 4.8 and 8 gpm/ft^2. With the exception of ^{24}Na and ^{51}Cr, the higher concentrations of all radioisotopes occurred at the higher flow rate. It was concluded that the higher activity at higher flow was a result of mechanical fracture of the floc particles under increased hydrostatic pressure. (M.C.G.)

684 (HW-81746(p.3.30-2)) THE EFFECT OF DEIONIZED WATER ON REACTOR EFFLUENT ACTIVITIES. I. NEW TUBES AND NEW FUEL CHARGES. W. B. Silker and C. W. Thomas (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

The relationship between reactor effluent activities and tube and fuel jacket surfaces was studied by measuring the concentration buildup of radioisotopes in the effluent from zirconium and aluminum process tubes cooled with deionized water. The experimental results, which are described mathematically, indicated that nearly all radioisotope production was associated with the corrosion product on the aluminum components. It was postulated that ^{24}Na diffused from within the porous aluminum corrosion product, and the degree of porosity changed with tube age. Most isotopes were produced primarily on the fuel jacket surface, ^{65}Zn was the most notable exception. (auth)

685 (HW-81746(p.3.33-6)) THE EFFECT OF DEIONIZED WATER ON REACTOR EFFLUENT ACTIVITIES. II. ZIRCONIUM AND ALUMINUM-CLAD FUEL. W. B. Silker and C. W. Thomas (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

The relative importance of the aluminum tube and fuel jacket surfaces in the production of reactor effluent radionuclides was investigated. ^{65}Zn was derived primarily from the tube; ^{56}Mn, ^{239}Np, and ^{72}Ga were produced in equal amounts on the two surfaces; and ^{24}Na, ^{76}As, ^{140}La, ^{64}Cu, ^{32}P, and ^{65}Ni production favored the fuel element surface. (auth)

686 (HW-81746(p.3.42-3)) SUBSTITUTION OF POLYELECTROLYTES FOR ALUM IN WATER TREATMENT. W. B. Silker (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Investigations were made to determine the possibility of substituting a positively charged polyelectrolyte for a portion of the alum flocculant used in water treatment. As much as half of the alum was replaced with a cationic polyelectrolyte with no decrease in process efficiency. It appeared mandatory to make alum and polyelectrolyte additions at the same location. (auth)

687 (HW-81746(p.5.25-8)) A GLOVE BOX AIR BALANCE MONITOR. N. S. Porter (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

An instrument was developed for use at the Biology Inhalation Toxicology Laboratory to monitor the negative air differential across a glove box. A manometer is filled with black (dyed) ethylene glycol and is mounted on a chassis in a photocell light beam. Loss of air balance causes the fluid to interrupt the light beam, which causes the alarm to operate. The photocell circuitry is powered by the same 110-v a-c source that supplies the air balance fans; hence, loss of that power also operates the alarm. The alarm is a battery-operated variable frequency oscillator and amplifier driving a loudspeaker. There is no standby power consumption and maximum current drain during alarm is only 0.6 mamp. The two mercury cell batteries can provide over 3000 hr of alarm time at this rate. The manometer will energize the alarm circuit when the loss of air balance differential is as small as 0.1 in. of water equivalent. (auth)

688 (HW-81746(p.5.59-65)) AIRBORNE PLUTONIUM DETECTION. D. P. Brown (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Alpha energy analysis techniques for the detection of airborne plutonium contamination were investigated. An experimental system was assembled and tested and work was initiated on a demonstration model to be used during biological inhalation studies. The original development work was started late in 1962. As a matter of review, detection of the ^{239}Pu maximum permissible air concentration (MPC) of 2×10^{-12} μcuries/cm^3 was complicated by a varying background of natural alpha emitters. Since one MPC of airborne ^{239}Pu is only 4.44×10^{-6} disintegrations/min/cm^3, it is necessary to integrate the activity on a filter to obtain adequate measurement sensitivity. Radon and thoron are also collected on the filter, and at times, their activity may accumulate to several hundred times the required detection level for ^{239}Pu. Methods for the detection of low-level plutonium air contamination were examined and a series of definitive experiments was carried out. A sensitivity of 40 MPC-hr was obtained using alpha energy analysis techniques where the contributions from higher energy radon and thoron, which appear in the ^{239}Pu channel, were compensated using electronic balancing circuitry. This provided a considerable reduction in complexity compared to other air particulate monitors of similar sensitivities. Additional experiments showed that gamma background levels of 2 mr/hr and beta particle levels of 2.4×10^4 disintegrations/min will not adversely affect the sensitivity or general operation. An increase in air flow rate and/or an increase in detector and filter diameter improves the basic sensitivity. (auth)

689 (HW-SA-3550) CALCULATION OF MPC$_E$ FOR U^{235} FISSION PRODUCT RADIOAEROSOLS. F. E. Owen (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). [May 26, 1964]. Contract AT(45-1)-1350. 14p. (CONF-642-7). Dep.(mn); $1.00(cy), 1(mn) OTS.

From Health Physics Society, Cincinnati, June 1964.

The effective maximum permissible concentration (MPC$_E$) for an airborne mixture of radionuclides may be calculated from the weighted averages of the radionulides present, based on their individual MPC$_A^{(1)}$ and the composition in the mixture. In developing an MPC$_E$, there are several factors which may be of considerable significance in the final result. The composition of a mixture is constantly changing with time as the various radionuclides decay away. Radionuclides decay by different modes, alpha, beta, and some by internal conversion with only a gamma emission. Each radionuclide has a different deposition affinity in the various organs of the body, thus requiring a separate set of MPC's for each organ. Solubility of the mixture or portions of the mixture also changes conditions. In some cases, it may be necessary to overcome the complication created by the interplay of these factors by arbitrarily assuming the most restrictive condition. The calculation of an applicable MPC$_E$ for airborne particulate contamination (radioaerosols) of a changing mixture is demonstrated.

Uranium-235 fission products were chosen to illustrate the method because they are prevalent at many reactors and supporting chemical separations facilities. The radioaerosol MPC_E for fission product mixtures from 70-days irradiation was calculated over a decay period of 1 to 1000 days. Four organs were considered, lung, GI tract, bone, and total body. During the first few months of decay, the MPC_E for the lungs is limiting, starting at 8×10^{-8} μc/cc after one day, and reducing to 3×10^{-8} μc/cc after three months. After six months, the MPC_E for bone becomes limiting, starting at 2×10^{-8} μc/cc, and reducing to 1×10^{-8} μc/cc after a year and to 2.7×10^{-9} μc/cc after 1000 days. (auth)

690 (JAERI-1059) SKIN CONTAMINATION BY ^{137}Cs AND ITS DECONTAMINATION. Yoshinori Inoue, Yoshiki Wadachi, and Yoshito Yamaoka (Japan Atomic Energy Research Inst., Tokyo). July 1964. 7p. (In Japanese). Dep.(mn).

The relation between the amount of $^{137}CsCl$ adsorbed on the skin and time on the contamination of rabbit skin by ^{137}Cs was studied. The results showed that skin contamination increased exponentially with time. The effectiveness of water, sodium dodycyl benzene sulfonate (DBS), and TiO_2 paste for the decontamination of skin was compared. Results showed that DBS was most effective if used within 20 min. after contamination and TiO_2 paste was most effective after that time. The need for care in handling ^{137}Cs and early decontamination in the event of skin contamination are stressed. (C.H.)

691 (NP-14394) DATA FROM RADIATION PROTECTION PROGRAMS. Volume 2, No. 9. (Canada. Dept. of National Health and Welfare, Ottawa). Sept. 1964. 46p. (In English and French). Dep.(mn).

Data are presented on radioactivity due to fallout in samples of air, precipitation, and milk collected at various locations throughout Canada during Aug. 1964. Results are included from radiological surveys of reactor sites and film badge monitoring programs for radiation workers. The Canadian regulations governing the shipping of radioisotopes and safety procedures required for a radioisotope license are discussed. (C.H.)

692 (NP-14407) COMMONWEALTH X-RAY AND RADIUM LABORATORY ANNUAL REPORT TO THE DIRECTOR-GENERAL OF HEALTH FOR THE YEAR ENDED JUNE, 1964. (Australia. Commonwealth X-Ray and Radium Lab., Melbourne). 25p. Dep.(mn).

The functions of the Laboratory are reviewed. These include the procurement of radioisotopes for medical applications, the measurement of radioactive materials in foods and biological samples, the control of radium used in therapy, radiation protection and radiation monitoring activities, and assistance in problems involving diagnostic and therapeutic radiology. Activities for the year ending June 30, 1964, are summarized. (C.H.)

693 (THAI-AEC-1) RADIATION SAFETY MANUAL. (Thailand. Office of Atomic Energy for Peace, Bangkok). Nov. 1963. 36p. Dep.(mn).

Rules and procedures relating to radiation safety are presented for all Thai AEC operations. (C.H.)

694 (TID-7696(p.1-9)) BERYLLIUM SMEAR SAMPLING—IS IT USEFUL? John Zdanowicz (Pratt and Whitney Aircraft Div., United Aircraft Corp. Connecticut Aircraft Nuclear Engine Lab., Middletown).

A colorimetric semi-quantitative method is presented for analyzing Be smear samples. Although the analysis of smear samples has been open to question, to overcome the questionability of the analysis, one would have to employ more exacting methods which are time consuming and costly. If one accepts the smear technique, results obtained and its limitations, then the smear technique serves a very useful purpose as it is applied to good housekeeping and working environment. (auth)

695 (TID-21239) PREDICTION OF LEVELS OF Sr^{90} AND Cs^{137} IN FOOD AND MAN. (New York Operations Office. Health and Safety Lab., AEC). May 27, 1963. 20p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Prediction techniques and predictions of the levels of strontium-90 and cesium-137 in foods and in man are described. The values are based on the predicted levels of these nuclides in fallout and the predicted time pattern of this fallout. The predictions cover the years 1963, 1964, and 1965 and attempt to differentiate between the wet and dry areas of the United States. At best, the predictions are limited to broad averages. The attempt to predict the location and magnitude of so-called "hot spots" is probably valueless. On the other hand, the general geographical distribution of results of past measurements probably is applicable to the predictions. (auth)

696 (UJV-1114/64) EFFEKTIVNOST' DEZAKTIVATSII I KORROZIINOE VOZDEISTVIE NEKOTORYKH DEZAKTIVIRUYUSHCHIKH RASTVOROV. (Decontamination Efficiency and Corrosive Effects of Certain Deactivating Solutions). O. Bartl and Z. Dlougi (Československá Akademie Věd. Ústav Jaderného Výzkumu, Řež). [1962]. 17p. Dep.(mc).

Five decontamination processes were evaluated for efficiency and corrosive effects on clean and oxidized carbon and stainless steel surfaces: (1) APAC; washing with 20% NaOH + 5% $KMnO_4$ followed by 10% $(NH_4)_3\ C_6H_5O_7$. (2) APACE; same as APAC except using 0.5% Chelaton 3 with the $(NH_4)_3\ C_6H_5O_7$. (3) Turco; washing with 0.5% NaF + 2.1% NH_2HSO_3 + 1.9% NaCl + 0.23% Chelaton 2. (4) Oxalate; washing with 3.8% $(NH_4)_2C_2O_4$ + 3.4% H_2O_2 + $H_2C_2O_4$ at pH 4.5. (5) A-1; washing with 5.0% NaOH + 0.1% $KMnO_4$ followed by 5.0% HNO_3 + 0.2% $H_2C_2O_4$ + 0.2% $CS(NH_2)_2$ + 0.2% NaF followed by 5.0% HNO_3 + 0.2% $H_2C_2O_4$. Processes 1, 2, 4, and 5 were found to be effective for oxidized carbon steel and clean and oxidized stainless steel. (R.V.J.)

697 (VUF-1009) FINAL REPORT OF OFF-SITE SURVEILLANCE FOR PROJECT SHOAL OF OCTOBER 26, 1963. (Southwestern Radiological Health Lab., Las Vegas, Nev.). Sept. 1, 1964. Contract [AT(29-2)-1226]. 31p. (SWRHL-5r). Dep.; $2.00(cy), 1(mn) OTS.

Project Shoal, which took place at a location near Fallon, Nevada on October 26, 1963 at 1000 PDT, was an underground nuclear detonation conducted as a part of the Vela program of the Department of Defense. The Off-Site Radiological Safety Program of the U. S. Public Health Service's Southwestern Radiological Health Laboratory monitored the public area surrounding the site and collected and analyzed several hundred water, milk, and air samples before and for several weeks after the event. Analysis of these samples indicated that the radioactive material from the Shoal event was completely contained. During post-shot drilling operations an intermittent release of gaseous material containing fresh fission products occurred, but was not detected on air samplers located in populated areas or in milk and water samples taken since that time. (auth)

698 (VUF-1012) ON-SITE HEALTH-AND-SAFETY REPORT. [Final Report]. Bernard F. Eubank and Alan W. Ward, comps. and eds. (Reynolds Electrical and Engineering Co., Inc. Health and Safety Div., Mercury, Nev.). June 1964. Project SHOAL. Contract AT(29-2)-162. 36p. Dep.; $2.00(cy), 1(mn) OTS.

Project Shoal was an underground nuclear test detonated near Fallon, Nevada, at 10 a.m., Oct 26, 1963. It was part of the Vela-Uniform Program to develop ways of detecting underground nuclear blasts. The detonation took place in a deep shaft of granite in an earthquake area so blast effects could be compared with earthquake effects. Radiological safety activities included detection, identification, location, and plotting of radiation intensities at the site, measurement of radiation intensities and doses, providing protection from radiation and contamination, and personnel dosimetry. Data are presented and comparisons are made with pre-shot measurements. (C.H.)

699 PROTECTIVE CLOTHING AGAINST CONTAMINATION. B. Rodenbaeck (Kernforschungsanlage, Julich, Ger.). Kerntechnik, 6: 419-20(Sept. 1964). (In German)

Certain necessities concerning kind and thickness of weaving, pattern, and decontaminability are required of protective clothing that has to be worn when handling ra-

dioactive materials. The details of these requirements are discussed. (auth)

700 SOME RESULTS OF RADIOMETRIC MEASUREMENTS AT HEIGHTS OF 200-400 km DURING 1960-1963. S. N. Vernov, I. A. Savenko, P. I. Shavrin, V. E. Nesterov, N. F. Pisarenko, M. V. Teltsov, T. I. Pervaya, and V. N. Erofeeva. Kosmich. Issled., 2: 136-46(1964).

Measurements made by 15 satellites and spaceships (the second and third spaceships, satellites of the Cosmos series, and Vostok spaceships) during the period from August 1960 through June 1963 at heights of 175 to 405 km were used to determine the daily values of the radiation dose for various flight trajectories; these doses were 10 to 55 mRad/day and are not dangerous for astronauts when the shielding of the ship is denser than 3 to 5 g/cm^2. At the time of measurements in April 1962 and June 1963 it was found that there was an increase by a factor of 1.2 in the intensity of cosmic radiation in the high latitudes where the magnetic rigidity does not exceed 5.4 Bev. There was no increase of intensity in the equatorial latitudes (magnetic rigidity greater than 5.4 Bev). These facts confirm the assumption of a genetic relationship between excess cosmic radiation recorded at heights of 200 to 400 km and primary cosmic radiation. Using mirror points at heights of about 350 to 370 km, it was possible to determine the lifetime of the particles of the artificial radiation belt as approximately 3 months. For orbits of 210 to 369 km the dose caused by the artificial radiation belt 20 days after its formation was almost 3 times as large as the dose caused by cosmic radiation in the natural belts. The dependence of the mean daily intensity caused by the radiation belts on height was determined. In an orbit of 207 to 407 km this intensity was 5.6 times as large as in an orbit of 209 to 301 km. The contribution to the dose by the radiation belts for satellites with an apogee of 400 km becomes equal to the dose caused by cosmic radiation. The characteristics of the radiometric apparatus carried aboard the Cosmos satellites are listed, and data on the 15 satellites and spaceships and the absorbed dose measured by each are tabulated. (OTS)

701 Sr-90 IN DIET IN POLAND (1 AUGUST 1960 TO 31 JULY 1961). Wanda Czosnowska (Inst. of Occupational Medicine, Lodz, Poland). Nukleonika, 9: 471-81 (1964).

The level of ^{90}Sr in the diet in Poland was investigated in the period from 1 August 1960 through 31 July 1961. A systematic sampling of foodstuffs in Poland with subsequent determination of Sr-90 as well as statistical data on consumption served as a basis for calculation of the average intake in urban and rural regions of the country. This amounted to 13.2 and 18.9 pC per day, respectively; the concentration of Sr-90/g Ca in average rural and urban diet in the period of investigation was 15.5 and 18.4 pC/g Ca. (auth)

702 Sr-90 IN THE DIET IN POLAND (AUGUST 1961–JULY 1962). Wanda Czosnowska (Inst. of Occupational Medicine, Lodz, Poland). Nukleonika, 9: 745-55(1964).

Data are presented on the average daily intake of ^{90}Sr in Poland from August 1961 through July 1962. For urban and rural population the intake amounted to 12.9 and 18.9 $\mu\mu$C per day, respectively. The ^{90}Sr to calcium ratio in diet of both groups was 17.6 and 18.4 $\mu\mu$C per gram Ca, respectively. On the basis of ^{90}Sr/g Ca in the milk and other foodstuffs the variation of the ratio: ^{90}Sr/g Ca total diet/^{90}Sr/g Ca milk is discussed. The concept to use the ^{90}Sr/g Ca ratio in pooled urine samples as a measure of contamination of the average diet is evaluated and discussed. (auth)

703 THE USE OF SEMICONDUCTOR SPECTROMETER FOR FAST IDENTIFICATION OF ALPHA EMITTING NUCLIDES IN URINE. Jerzy Roman, Jan Bilkiewicz, and Janina Chwaszczewska (Central Lab. for Radiological Protection, Warsaw and Inst. of Nuclear Research, Warsaw). Nuklecnika, 9: 779-84(1964).

Silicon surface-barrier spectrometer, with a sensitive area of 200 mm^2 is used for fast identification of alpha-emitting nuclides in urine. This spectrometer has proved to be suitable for analyzing the alpha nuclides activity in urine, down to 10^{-13} c/mg of ash, with an energy resolution better than 100 kev at 5.3 Mev, and the background counting rate less than 2 cph in the energy range from 4 to 9 Mev. This type of alpha analysis will permit to carry out most of the routine identification of alpha contamination in urine simultaneously enabling one to avoid the time consuming radiochemical sample preparation. The obtained spectra were illustrated. (auth)

704 DECONTAMINATION OF OBJECTS AND SURFACES CONTAMINATED WITH RADIOACTIVE SUBSTANCES. II. EXPERIMENTAL PART. Tr. Gheorghiu, D. Serban, T. Vlad, and C. Licaret. Rev. Chim. (Bucharest), 15: 218-19(1964).

The following materials were contaminated with 1 cm^3 of radioactive solution of 5 to 10 microcurie/cm^3 and dried in sunlight: glass, tin cans, aluminum foil, iron plates, linoleum, and unplasticized polyvinylchloride. Eleven radioactive isotopes were used in different water soluble salts: ^{32}P(Na_2HOP_4), ^{51}Cr($Cr(NO_3)_3$), ^{60}Co($Co(NO_3)_3$), ^{65}Zn($ZnCl_2$), ^{75}Se($Se(NO_3)_2$), ^{90}Sr($Sr(NO_3)_2$), ^{95}Zr($Zr(C_2O_4)_2$), ^{110}Ag($AgNO_3$), ^{124}Sb($SbCl_3$), ^{131}I(NaI), and ^{147}Pm($Pm(NO_3)_3$). The decontamination was carried out immediately after drying or 24, 48, 120, and 360 hours after contamination, by washing and wiping with different reagents (water, ethanol, HCl (3, 10, and 15%), citric acid (2 and 5%), sodium citrate (2 and 5%), ammonium citrate (2 and 5%), H_3PO_4 (1%), CH_3COOH (10%), HNO_3 (3%), H_2SO_4 (1%), ligroin, Na_3PO_4 (1%), citazol (0.5%), EDTA (0.5%), $K_2Cr_2O_7$ (5%), and Na_2CO_3 (5%)). The remaining radioactivity was measured with a radiometer at 5 cm distance from the sample. The results are presented in six ternary diagrams. (OTS)

705 A CASE OF ACCIDENTAL CONTAMINATION WITH POLONIUM-210. N. Racoveanu, S. Bergheanu, O. Cavulea, and Gh. Furnica. Rev. Sanit. Mil., 60: 463-5 (May-June 1964).

A minor accident due to improperly supervised use of a Po–Be neutron source is described. Three persons were interned for investigation after having been in contact with the source. Laboratory examinations or radiometric studies showed no pathological changes, but urine tests made 21 days after the irradiation showed that the least exposed person's urinary excretion contained about 40 pC of ^{210}Po. (OTS)

706 THE APPLICABILITY OF α-EMITTING SOURCE TO SOME MEASUREMENTS RELATED TO MINE SAFETY. Kiso Matsuguma, Shigeyoshi Oba, and Ikuhide Takiguchi. Saiko To Hoan, 8: 617-25(Dec. 1962). (In Japanese)

The ionization current between 2 electrodes varies due to chamber conditions. An α-source of about 10 μC ^{226}Ra was galvanized on the center of a (0.2 × 1.5 × 20)mm Ag foil. Five or 6 of these foils were placed on the inside surface of the cathode of either parallel plate type or cylindrical type. The changes in the ionization current were studied with respect to the air velocity, CH_4, and airborne dust concentrations. The applicability of the apparatus to air velocity measurement was confirmed. The current decreases exponentially with air velocity, with suitably chosen electrode distance, and potential difference. Current increases linearly with CH_4 content in the range of 10 ~ 50%. The possibility of measuring the airborne dust by means of this α-emitting source was not established. (OID)

707 TRITIUM MICRODOSIMETRY. Stefan Bleecken (Institut fur Mikrobiologie und Experimentelle Therapie, Deutsche Akademie der Wissenschaften, Berlin). Strahlentherapie, 125: 145-57(Sept. 1964). (In German)

Since direct experimental tests for calculated radiation doses involving tritiated objects are very difficult, an indirect test using radioautographic results was performed. The results can be explained satisfactorily if the dose calculations are based on the function e^{-kR}/R^2 and not on a function proposed by Robertson, which has usually been used. The given equations and diagrams can be used for simple calculations of radiation doses in tritiated cells and cell elements, respectively. (auth)

708 RADIOACTIVE FALLOUT IN PRAGUE IN 1963. Kvetoslav Spurny and Oldrich Machala (Inst. of Physical Chemistry, Prague). Zdravotni Tech. Vzduchotech., 7: 149-51(1964).

Additional results on measurements on the radioactive fallout in the Prague area in 1963 are presented, indicating its course throughout the year and the effect of the cessation of testing nuclear weapons. (OTS)

709 RECENT PUBLICATIONS OF PHYSICAL AND PHYSICOCHEMICAL AEROSOL RESEARCH. H. Mohrmann (Universität, Göttingen, Ger.). Zentr. Biol. Aerosol Forsch., 10: 326-50(Aug. 1962). (In German)

A review of recent experimental findings in fields included within aerosol research is presented. These include several subheadings, such as formation of aerosols, general properties, electrical properties, analysis of aerosols, deposition of aerosols, and relations of radioactive aerosols to atmospheric contamination. The deposition of radioactive atoms on aerosol particles is related to several parameters. These include particle radius, kinetic diffusion velocity of the atoms, and concentration of the suspended particles. The physical basis and practical possibility of purification of air containing radioactive aerosols is discussed. References cited, 124. (TCO)

710 KRATKII SPRAVOCHNIK PO RADIATSIONNOI ZASHCHITE I DOZIMETRII. (A Handbook on Radiation Protection and Dosimetry). A. A. Moiseev and V. I. Ivanov. Moscow, Atomizdat, 1964. 183p.

Radiation protection and dosimetry and radioisotope distributions in the biosphere and in human tissues are reviewed. Methods are suggested for calculating doses from natural and artificial sources and permissible doses in handling radioactive materials. Data are also included on maximum permissible radiation levels for water and air. (R.V.J.)

711 AEROSOLI. (Aerosols). K. Spurnyi, Ch. Iex, B. Sedlachek, and O. Shtorkh. Moscow, Atomizdat, 1964. 359p.

Physico-chemical and biological properties of aerosols are studied, and methods for measuring and filtering air pollution from industrial dust, smoke, steam, and radioactive stack disposal are discussed. Monitoring devices and filters are described. 344 references are included. (R.V.J.)

712 MANUAL OF INDUSTRIAL RADIATION PROTECTION. PART II. MODEL CODE OF SAFETY REGULATIONS (IONISING RADIATIONS). Geneva, International Labour Office, 1959. 58p. $0.75; 4s. 6d.

Revisions of section 2 Chapter XI of the Model Code of Safety Regulations for Industrial Establishments for the Guidance of Governments and Industry are presented. A model code of safety regulations (ionizing radiation) includes: maximum permissible doses; general provisions relating to all processes involving a radiation hazard; sealed sources and equipment generating ionizing radiations; and unsealed radiation sources. (H.M.G.)

713 SAFETY AND THE PUBLIC RESPONSIBILITIES OF THE ATOMIC COMMUNITY. A PANEL DISCUSSION. p.124-38 of "Proceedings of the Tenth Anniversary Conference of the Atomic Industrial Forum." New York, Atomic Industrial Forum, 1964.

The public safety as related to nuclear energy is discussed, emphasizing reactor safety research, the safety record of the nuclear industry and operating reactors, and the difficulties of educating the public. (D.C.W.)

714 STATUS OF PROPOSED TRANSPORTATION REGULATION. Robert Baker. 14p. (CONF-620-3)

From Institute of Nuclear Materials Management 5th Annual Meeting, Pittsburgh, May 1964.

Most international shipments of radioactive material, particularly those to Europe, Great Britain and Australia, are subject to rules based on regulations developed by the IAEA. The IAEA rules and many of the rules of those countries mentioned are undergoing some revision at present. The revision of the IAEA rules was proposed to their Board of Governors and will likely be considered by them in time. The International Air Transport Association also is revising their rules based on the latest IAEA proposals. The AEC's 10 CFR Part 71, applicable to the shipment of special nuclear material, has been in effect since 1958. A proposed revision was issued in March 1963 and a redraft of that proposal is being developed. For irradiated fuel shipping containers, the AEC issued 10 CFR Part 72 proposed in September 1961 and the criteria in that proposal are being used for licensing. The ICC regulations have been in effect since 1948. Major changes, proposed in 1963, are currently being redrafted, taking into account a number of comments and the further work of the IAEA. A proposed revision, applicable only to fissile material, was issued in January 1964. (auth)

715 SHIELDING FOR TEMPORARY RADIATION PROTECTION FOR MOUNTING WORK ON TUBE INLETS IN RADIOACTIVELY CONTAMINATED ROOMS. Peter Braumer (to Brown, Boveri and Cie, AG). German Patent 1,171,545. June 4, 1964. Filed Dec. 30, 1961.

The shield is composed of a semicircular main piece and two circular sectors pivotally connected to the main piece and guided by a bag. The bag guides the suspending circular sectors in such a way that they are closed to form an iris diaphragm. (Gmelin Inst.)

INSTRUMENTATION

General

Refer also to abstracts 309, 856, and 1176.

716 (AERE-M-1459) A SYMMETRICAL CHANNEL BIASSING CIRCUIT. H. J. Reid (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Aug. 1964. 7p. Dep.; $0.30(BIS), 1s. 9d.(HMSO).

A circuit is described that enables a channel to be varied symmetrically about the center of a photopeak. The circuit was applied to tunnel diode discriminators. (auth)

717 (AERE-M-1472) NOTES CONCERNING MAGNETIC TAPE RECORDING. J. W. Hall (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Jan. 1961. Amended June 1964. 27p. Dep.; $0.80(BIS), 4s.(HMSO).

Information is given for users of digital tape recording methods at Harwell. A historical outline of the use of tape is also given. To facilitate the use of this report as a reference, a list of the topics dealt within each paragraph is included. (auth)

718 (CEA-R-2383) MAGNÉTOMÈTRE ABSOLU À RÉSONANCE MAGNÉTIQUE NUCLÉAIRE. (An Absolute Nuclear Magnetic Resonance Magnetometer). Antoine Salvi (France. Commissariat a l'Énergie Atomique. Centre d'Etudes Nucléaires, Grenoble). 1964. 56p. Dep.(mn).

Thesis submitted to Université, Grenoble, France.

An NMR magnetometer is described. A crossed-coil nuclear oscillator, which operates continuously over a wide range (800 gamma) is described. Frequency-field conversion accuracy is discussed. (R.E.U.)

719 (CEA-R-2462) REALISATION D'UN APPAREIL DE PHOTOLYSE-ECLAIR A FAIBLE DUREE DE DECHARGE. (Construction of a Flash-Photolysis Apparatus Having a Short Discharge Time). Claude Devillers (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). 1964. 18p. Dep.(mn).

Flash photolysis aims at reaching directly the primary mechanisms resulting from the action of light on an absorbent matter. This makes it necessary to produce a flash as short and as bright as possible. The main effort was directed towards reducing the duration of the flash by decreasing the self-inductance of the discharge circuit. A description of this circuit and study of the characteristics of the apparatus are followed by a short description of the two analytical methods: flash spectrography and absorption spectrophotometry at a given wave-length. (auth)

720 (COO-401-105) AIR EJECTOR PARTICLE SAMPLER. A Progress Report. Report No. 2584. R. C. Wood, ed. (Litton Systems, Inc. Applied Science Div., St. Paul). Sept. 1, 1964. Contract AT(11-1)-401. 76p.

Theoretical and experimental studies of a balloon-borne air-ejector-powered particle collector for stratosphere application are described. This device was tested in an altitude chamber and carried on three research balloon flights to 128,000 ft. At the 128,000 ft level, 87,900 ft^3 of air were processed in 144 min. Although the ejector sampler is being developed for 100,000 to 150,000 ft region, preliminary calculations indicate that it may be used at 60,000 ft if comparisons include reliability factors. (N.W.R.)

721 (DP-904(p.29-33)) INTERSITE EXCHANGE OF TUNGSTEN STANDARD SAMPLES. R. S. Wood, Jr. (Du Pont de Nemours (E. I.) & Co. Savannah River Plant, Aiken, S. C.).

Tungsten diffraction standards were prepared by J. P. LeGeros of the Savannah River Plant for x-ray diffraction and were presented to members of the Preferred Orientation Committee at the December 1961 meeting. Each member was asked to diffract six planes and calculate a standardized value for each plane. There were wide and statistically significant differences between data from the various sites. Data were tested by the t test, however, and the hypothesis that the data came from the same population is at least 85% correct. More work in intersite standardization of methods is needed if meaningful intersite exchange of data is to be accomplished. (auth)

722 (HW-68302) A KEYBOARD FOR THE ENTRY OF DATA INTO A MULTICHANNEL ANALYZER MEMORY. G. E. Driver (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Jan. 30, 1961. Con-Contract AT(45-1)-1350. 4p. Dep.(mn); $1.00(cy), 1(mn) OTS.

In order to identify spectra recorded on the magnetic tapes, calendar and personnel data will be magnetically recorded on the same tape. The manual entry of the data onto tape involves the feeding of the data into the multichannel analyzer magnetic core memory, and this problem is solved by modifying the timing sequence of functions in the "print" mode of the analyzer. The normal print mode and the keyboard entry sequence are described. (D.L.C.)

723 (HW-74293) CIRCUITS FOR THE MANUAL ENTRY OF DATA ON PUNCHED PAPER TAPE: RIDL 52-24 CONVERTER WITH TALLY PUNCH. G. E. Driver (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). June 27, 1962. Contract AT(45-1)-1350. 8p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Simple keyboard circuits are being used to punch calendar and personnel information on paper tapes along with the pulse-height analyzer data from Hanford's Whole Body Counting Facility, for processing by an IBM 7090. A description is given of the circuits and their operation. (D.L.C.)

724 (HW-78146) A GLOVE BOX AIR BALANCE MONITOR AND ALARM. S. N. McAllister and N. S. Porter (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). July 2, 1963. Contract AT(45-1)-1350. 6p. Dep.(mn); $1.00(cy), 1(mn) OTS.

An instrument was developed for use by Biology Laboratory personnel which uses a manometer to monitor the negative air differential across the glove box. This manometer is filled with black (dyed) ethylene glycol and is mounted on a chassis in a photocell light beam. Loss of air balance causes the fluid to interrupt the light beam which causes the alarm to operate. The photocell circuitry is powered by the same 110 VAC source that supplies the air balance fans; hence, loss of that power also operates the alarm. The alarm is a battery-operated variable frequency oscillator and amplifier driving a loudspeaker. There is no standby power consumption and maximum current drain during alarm is only 0.6 milliamps. The two Mallory TR 233R mercury cell batteries can provide over 3000 hours of alarm time at this rate. (auth)

725 (IDO-16975) AN ELECTROCHEMICAL CELL NOISE STUDY. R. H. Brown, L. G. Cloud, and S. J. Horn (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). June 1964. Contract AT(10-1)-205. 16p. Dep.; $1.00(cy), 1(mn) OTS.

A description is given of the noise output of a bubbling electrolytic cell under various conditions of cell operation. The noise spectrum is analyzed and integrated for the purpose of providing a potentiostat noise figure. An indication is given of how a noise spectrum may be used to gain further insight into electrochemical cell mechanisms. (auth)

726 (JAERI-1064) CONSTRUCTION OF PRECISE PRESSURE GAUGE FOR FLUORINE GAS AND VAPORS OF REACTIVE FLUORIDES. Shigeo Tsujimura, Akira

Takahashi, Ginji Fujisawa, and Keizo Suzuki (Japan Atomic Energy Research Inst., Tokyo). May 22, 1964. 28p. (In Japanese). Dep.(mn).

A precise pressure gage is described which was developed to measure the pressure of fluorine gas and the vapors of reactive fluorides. The pressure of fluorine or fluorides was transmitted through a phosphor bronze bellows electroplated with nickel which was restored to its initial null extension by the adjustment of the external pressure of an inner gas. The pressure to be measured is equal to the balancing pressure of the inner gas when the bellows is in its null extension. The extension of the bellows was determined with a differential transformer, the core of which was attached to the bellows through a connecting rod. The balancing pressure of the inner gas was read on a U tube manometer. The accuracy of the gage was determined to be better than 0.2 mm Hg at pressures up to 1000 mm Hg. The use of the bellows gage as a deflection type instrument was described and its usefullness for the measurement of the fast pressure change was also mentioned. The following examples of the uses of the bellows gage are given and the results obtained are compared with the reported values. 1) The vapor pressure of uranium hexafluoride at 0°C. 2) The equilibrium decomposition pressure of uranium hexafluoride for the reaction $NaF \cdot x\ UF_6$ (solid) = $x\ UF_6$ (gas) + NaF (solid). An account is given of the construction of a pressure gage provided with a nickel diaphragm as a sensing element. The work, however, was stopped without much success. (auth)

727 (LNF-64/17) TWO CIRCUIT MODULES OF A 100 MEGAPULSES/SEC UNIT, FOR NUCLEAR EXPERIMENTATION. Note No. 241. M. Coli, G. Mazza, and A. Villalba (Italy. Comitato Nazionale per l'Energia Nucleare. Laboratori Nazionali, Frascati). May 18, 1964. 11p. Dep.(mn).

The functional elements that belong to an automatic pulse selection and registration unit with dead-time less than 10 nsec, particularly suited for nuclear physics experiments with high flux of particles from accelerating machines, are described. Included are: (a) fast coincidence circuitry with anticoincidence and resolving time less than 2 nsec; and (b) current linear gate with linearity better than 1% for pulses from 1 to 20 mamp amplitude. (auth)

728 (ORNL-3676(p.163-6)) PHASE MODULATION OF INJECTED CARRIERS. J. C. Pigg and C. C. Robinson (Oak Ridge National Lab., Tenn.).

Electrical signals were amplified by phase modulation of an excess carrier concentration in germanium. The observed amplification is a function of excess carrier concentration, frequency of the signal, and other factors. (auth)

729 (ORNL-P-532) PROGRESS REPORT FOR THE PHYSICAL PROPERTIES GROUP OF THE REACTOR DIVISION AT THE OAK RIDGE NATIONAL LABORATORY. J. W. Cooke (Oak Ridge National Lab., Tenn.). [1964]. Contract W-7405-eng-26. 7p. (CONF-764-7) Dep.(mn); $1.00(cy), 1(mn) OTS.

From Thermal Conductivity Conference, San Francisco, Oct. 1964.

Two thermal conductivity apparatus are described. One, an absolute variable-gap apparatus, will be used for corrosive low-conductivity molten salts up to 1000°C. The other, a radial flow apparatus, is being used for low-conductivity, solid plastics over the temperature range from −100 to 200°C. (N.W.R.)

730 (UCRL-7902(Rev.1)) AN AUTOMATIC CALIBRATION SYSTEM FOR MEASURING ELECTRICAL RESISTANCE AT HIGH PRESSURES. H. D. Stromberg and D. R. Stephens (California. Univ., Livermore. Lawrence Radiation Lab.). Aug. 13, 1964. Contract W-7405-eng-48. 12p. (CONF-763-1). Dep.(mn); $1.00(cy), 1(mn) OTS.

From American Society of Mechanical Engineers, Winter Meeting, New York, Nov.-Dec. 1964.

An improved method for measuring electrical resistance at high pressure is described. Bridgman anvils are employed. Two reference standards, either bismuth and barium or bismuth and tin, are run simultaneously with the unknown to obtain pressure calibration. The method is described and typical data obtained with lead and beryllium are shown. (auth)

731 (UCRL-7992) NOTE CONCERNING AN ELECTRICAL HEATER ERROR IN THE ROCKING-BOMB SOLUTION CALORIMETERS. Stuart R. Gunn (California. Univ., Livermore. Lawrence Radiation Lab.). July 29, 1964. Contract W-7405-eng-48. 9p. Dep.; $1.00(cy), 1(mn) OTS.

A discussion is given of an error that was found in the calibration of the rocking-bomb calorimeters used to measure heats of solution. The use of copper in the heater allows undesirable heat conduction to the bore and outer end of the heater spool, and observations of the superheating at several points are given. The heat of the reaction $H_2SO_4 \cdot 20\ H_2O + 2.50\ (NaOH \cdot 600\ H_2O) \rightarrow Na_2SO_4 \cdot 0.5\ NaOH \cdot 1522\ H_2O$ was measured using the 296.5- and 305.5-ohm heaters in one of the calorimeters; it was determined to be 32.593 ± 0.002 and 32.556 ± 0.001 kcal/mole, respectively. The difference is ascribed to differences in heat loss from the heater region. Corrections to previous investigations are given. (D.L.C.)

732 (UJV-1054/64) A MULTI-PURPOSE CHRONOMETER. B. Malý and F. Duda (Československá Akademie Ved. Ustav Jaderného Výzkumu, Řež). [nd]. 13p. Dep.(mn).

The multi-purpose chronometer is a fully transistorized instrument constructed with the use of printed circuits, intended for the generation and measurement of time intervals and for the counting of pulses. The fundamental components of the instrument are constituted by a triggered 1-Mc pulse series generator controlled by a 10-Mc crystal, and a decadic pulse counter with preselection of the initial state. The instrument is capable of replacing several single-purpose instruments. (D.L.C.)

733 (WAPD-T-1742) AN APPARATUS FOR THE MEASUREMENT OF THE THERMAL CONDUCTIVITY OF IRRADIATED SOLIDS IN THE RANGE 100-200°C. D. Jaffe (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). June 1964. Contract AT-11-1-GEN-14. 31p. (CONF-764-3). Dep.(mn); $2.00(cy), 1(mn).

From Thermal Conductivity Conference, San Francisco, Oct. 1964.

A comparative type apparatus was developed for measuring the thermal conductivity of thin (0.050 to 0.150 in.) specimens of solid materials having relatively high thermal conductivities, both prior to and after irradiation. The principle of measurement of the apparatus involves relating the time to boil a given volume of a liquid to the thermal resistance of the specimen, where thermal resistance = thickness/area × thermal conductivity. The apparatus has been calibrated for use with one-half-inch square specimens having thermal resistance values in the range of approximately 1 to 10 sec-°C/cal. In this range of thermal resistance values, the precision of the apparatus was found to be ±0.05 to 0.1 sec-°C/cal. To date, all measurements have been carried out at an average specimen temperature of 120°C, but this range can be extended to 100-200°C without major modifications to the apparatus. Also, it is felt that the apparatus can readily be calibrated and used for measurements of specimens with thermal resistance values well above 10 sec-°C/cal. Complete procedures for the remote in-cell measurement of the thermal conductivity of irradiated specimens have been developed and are described in detail. (auth)

734 SIMPLE HIGH SPEED KINEMATOGRAPHY OF NANOSECOND EXPOSURE. Heinz Fischer and A. Fritzsche (Technische Hochschule, Darmstadt, Ger.). Appl. Optics, 3: 1235-7(Nov. 1964).

Adequately timed, high-repetition-rate, nsec flashes for photographic observation of nonluminous particles of minute size are obtained by application of d-c voltage, and shot-rates up to 10 kc/sec are produced by such a free-firing source with a time jitter totaling ~0.3 msec. This simple

method is satisfactory for the microscopic evaluation of fluid dissipation processes. Studies of the statistics of over-all fluid motion require more exact timing if evaluated by a motion picture presentation. (auth)

735 NUCLEAR GYROSCOPES. James H. Simpson (General Precision, Inc., Pleasantville, N. Y.). Astronaut. Aeronaut., 2: 42-4; 47-8(Oct. 1964).

Static and dynamic means for instrumenting nuclear gyroscopes are discussed and analyzed. The performance, accuracy, and applications of nuclear gyroscopes are summarized. (T.F.H.)

736 CHARACTERISTICS OF A LOW ENERGY ION SOURCE. T. Sreenivasan and G. Carter (Univ. of Liverpool). J. Electron. Control (1), 17: 159-70(Aug. 1964).

The operating characteristics of a duoplasmatron type of low energy ion source for use with inert gases are described. It is shown that, even at low extraction potentials (≤5 kv) the gun perveance is high (25% maximum attainable), whereas the beam energy spread is tolerably small (about 6 ev). The gun was also designed to operate under ultra-high vacuum conditions. (auth)

737 INVESTIGATION OF THE STRUCTURE OF A BOILING LAYER USING GAMMA-RADIATION. A. A. Akhromenkov. Khim. i Tekhnol. Topliv i Masel, No. 4, 61-3(Apr. 1964). (In Russian)

Descriptions are given of a γ-radiometric device for continuously recording a boiling layer. The device is capable of determining the distribution of fine-grain materials in various reactor zones and recording bubbles and their relative dimensions. Various examples are given of the application of the device, and the recording curves are presented. (R.V.J.)

738 THE RESOLUTION FUNCTION OF A TWO-ROTOR NEUTRON VELOCITY SELECTOR. R. J. Royston (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nucl. Instr. Methods, 30: 184-202(Nov. 11, 1964).

Some general considerations of neutron pulses are given and are applied to yield the idea of an effective chopping point for a two-rotor system. The shape of a pulse from a system of parallel slot rotors is then calculated and the effects of slot multiplicity and rotor jitter are obtained. These results are used to derive the resolution function of a two-rotor velocity selector. (auth)

739 MEASUREMENT OF THE POLARIZATION OF A DEUTERON BEAM PRODUCED BY A POLARIZED ION SOURCE. E. R. Collins and H. F. Glavish (Univ. of Auckland, N. Z.). Nucl. Instr. Methods, 30: 245-51(Nov. 11, 1964).

A source for producing polarized protons or deuterons using an atomic beam method was previously described. The tensor polarization of the deuterons was measured by observing the asymmetry in the angular distribution of the neutrons from the $T(d,n)^4He$ reaction. Predicted and measured polarizations were compared. The advantages of a polarized ion source in angular distribution work is discussed. The effect of radio frequency transitions in the atomic beam on the tensor polarization of the deuterons was studied, and the r-f transition apparatus was found to work satisfactorily. (auth)

740 THE ABSOLUTE CALIBRATION OF A PROTON POLARIMETER. R. M. Craig (Univ. of Birmingham, Eng.), J. C. Dore, G. W. Greenlees, J. S. Lilley, J. Lowe, and P. C. Rowe. Nucl. Instr. Methods, 30: 268-70(Nov. 11, 1964).

An absolute calibration of the polarization efficiency of a proton polarimeter using the elastic scattering of 16-Mev protons by carbon at an angle of 45° was made. The efficiency was found to be 0.574 ± 0.009 for a mean energy of 15.7 Mev. (auth)

741 ELECTROMAGNETIC FOCUSING AND POLARIZATION OF NEUTRON BEAMS. P. S. Farago (Univ. of Edinburgh). Nucl. Instr. Methods, 30: 271-3(Nov. 11, 1964).

The application of methods used in the focusing and polarization of atomic beams is investigated. It is found that in spite of the small value of the magnetic moment of the neutron, focusing and a very high degree of polarization of slow neutrons with the aid of a magnetic six-pole lens are feasible. (auth)

742 A PENNING ION SOURCE FOR LITHIUM IONS. K. Bethge and E.Heinicke (Universität, Heidelberg). Nucl. Instr. Methods, 30: 283-6(Nov. 11, 1964). (In German)

A Penning ion source is described in which a Li plasma is established with Ar as the supporting gas. Under optimum operating conditions, negative lithium ions at 10^{-6} amp are obtained. (D.C.W.)

743 A BEAM SCANNER FOR TWO DIMENSIONAL SCANNING WITH ONE ROTATING WIRE. G. Hortig (Max-Planck-Institut für Kernphysik, Heidelberg). Nucl. Instr. Methods, 30: 355-6(Nov. 11, 1964).

A technique for obtaining a two-dimensional oscilloscopic display of the current density distribution of a beam is described, using a single rotating wire in the form of the more rigid half of an ellipse. (D.C.W.)

744 HIGH RESOLUTION ENERGY LOSS MAGNETIC ANALYZER FOR SCATTERING EXPERIMENTS. C. Schaerf and R. Scrimaglio (CNEN, Rome). Nucl. Instr. Methods, 30: 359-60(Nov. 11, 1964).

An integrated magnet system is described, which analyzes directly and with high resolution the energy loss in the target. (D.C.W.)

745 A SUPERCONDUCTING HELMHOLTZ PAIR. J. M. Younse and N. G. Einspruch (Texas Instruments Inc., Dallas). Proc. IEEE (Inst. Elec. Electron. Engrs.), 52: 1238-9(Oct. 1964).

A superconducting Helmholtz pair capable of delivering magnetic fields of sufficient uniformity over a practical working volume to perform a nuclear magnetic resonance experiment is described. Provision for achieving a-c field modulation with a superconducting coil is also made. (auth)

746 DESIGN OF A MERCURY VAPOR TARGET X-RAY TUBE. J. A. Bearden, F. N. Huffman, and Jon J. Spijkerman (Johns Hopkins Univ., Baltimore). Rev. Sci. Instr., 35: 1681-3(Dec. 1964).

A mercury vapor target x-ray tube was constructed and utilized for bremsstrahlung studies. An electrically heated boiler at the bottom of the target chamber vaporizes mercury which is expanded through a nozzle to form the target. The mercury jet expands into a water-cooled condenser at the top of the target chamber and the liquid mercury is returned to the boiler. A Pierce type electron gun provides the bombarding beam which exits from the high vacuum beam-formation region through a 3-mm-diam aperture into the higher pressure target chamber. The radiation produced can be observed from ports in the target chamber wall. The apparatus is operable up to 30 kv with beam currents as high as 50 mA. The equivalent solid thickness of the target ranges up to 500 Å, which yields a photon intensity near the high frequency limit comparable to that from a solid target. Design and operational features of the device are discussed. (auth)

747 SIMPLE DISPLAY SYSTEM FOR RECORDING TIME-RESOLVED MASS SPECTRA. Kenneth A. Lincoln (Naval Radiological Defense Lab., San Francisco). Rev. Sci. Instr., 35: 1688-91(Dec. 1964).

An uncomplicated photographic readout for recording rapidly changing mass spectra (of the order of milliseconds) generated by a time-of-flight instrument is achieved by a combination of two oscilloscopes equipped with Polaroid Land cameras. One of the oscilloscopes is operated by established techniques to display, quantitatively, peak height versus time for any one of the preselected mass peaks. Simultaneously, the second oscilloscope in the system displays a raster presentation of approximate peak height of all peaks in the spectrum as a function of time. In the latter case, the discrete m/e values are displayed on the horizontal axis as dots and the magnitude of the ion peaks is displayed qualitatively by z-axis modulation (intensification of the dots), while time is presented as the trace is displaced vertically by a raster voltage which is synchro-

nized with the time base of the first 'scope. The z-axis circuitry has been employed to further advantage by applying it to the monitoring oscilloscope during the customary time-of-flight spectral presentation (ion-peak height versus m/e) to intensify all the peaks of the oscilloscopic display, thus enhancing visual observation and photographic recording for all operations of the mass spectrometer. (auth)

748 BAUSCH AND LOMB SPECTROPHOTOMETER (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1160)

The electronic circuitry of a Bausch and Lomb (B&L) spectronic 20 Colorimeter-Spectrophotometer was modified to provide a d-c output signal for recording purposes. Various other mechanical changes were made to accommodate flow cells. Accuracy and stability of 1% of full scale with sensitivity to 0.3% of full scale are obtainable. Three drawings are included. (P.C.H.)

749 STABLE MILLIVOLT REFERENCE SUPPLY (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1161)

The voltage supply used for suppressing thermocouple emf's so that they may be read on a low-voltage (0 mv to 1 mv) recorder is described. The unit consists of a Zener diode regulated power supply and the Dekapot precision voltage divider. The Dekapot provides greater dial-setting accuracy. The unit is available in three ranges: 0 to 10, 0 to 50, and 0 to 100 mv. This voltage supply, including the Dekapot, is packaged on a $3\frac{1}{2}$ in. × 19 in. rack panel. One drawing is included. (P.C.H.)

Radiation Detection

Refer also to abstracts 703, 1194, 1569, and 1940.

750 (AD-601323) FINAL ENGINEERING REPORT FOR THERMOLUMINESCENT DOSIMETER COMPUTER-INDICATOR SYSTEM. Phases III and IV. Period Covered: October 15, 1962–February 29, 1964. (Edgerton, Germeshausen and Grier, Inc., Santa Barbara, Calif.). Mar. 31, 1964. Contract NObsr-85506. 35p. (S-248-R). $2.00 (OTS).

Five computer-indicators and 500 detectors based on the Phase II experimental models were produced. Official designations given to these units by BuShips are Computer Indicator, Radiac CP784 (XN-1)/PD and Detector, Radiac DT284 (XN-1)/PD. The production of the detectors involved the preparation of the thermoluminescent phosphor, the manufacture of the vacuum tube detectors, the digitally coded handles, locks, plastic tube bases and spacers, and the detector cases. A special plastic had to be selected for the tube bases and spacers when it was found that the standard type was unsatisfactory. The computer-indicators incorporated a new photomultiplier tube that increased the sensitivity over that obtained in the experimental model. Complete manufacturing drawings were made to produce the computer-indicator and detectors. Production tests on the detectors and computer-indicators indicate that the performance specifications of the contract were met. (auth)

751 (AECL-2042) A HIGH RANGE GAMMA RAY SURVEY METER. A. R. Jones and B. Banville (Atomic Energy of Canada Ltd., Chalk River, Ont.). July 1964. 12p. Dep.; $0.50(AECL).

A gamma survey meter to measure exposure rates in the range 2 to 500 roentgens/hour is described. It comprises a regulated high voltage supply, a miniature halogen counter tube, and a meter for measuring the current flowing in the counter tube. It includes a probe, at the end of which the counter tube is mounted, and this can be extended from two to five feet. Measurements of factors affecting accuracy are presented and discussed. The calibrating procedure is described. (auth)

752 (AEEW-R-375) THE USE OF THE CURRENT FLUCTUATIONS FROM A NEUTRON DETECTOR WITH LOGARITHMIC AMPLIFIERS AS A MEASURE OF NEUTRON FLUX LEVELS. E. P. Fowler and R. W. Levell (United Kingdom Atomic Energy Authority. Reactor Group., Atomic Energy Establishment, Winfrith, Dorset, England). June 1964. 50p. Dep.; $1.20(BIS), 6s.(HMSO).

Neutron flux is commonly measured with a mean current instrument at high flux levels and with pulse counting equipment at the lower flux levels. An alternative approach uses the statistical fluctuations of the current from an ionization chamber as a measure of neutron flux. A system of this type is described and it is shown that the system possesses some important advantages over conventional methods. (auth)

753 (AEEW-R-383) DEVELOPMENTS IN HIGH-TEMPERATURE NEUTRON DETECTORS. A. Goodings (United Kingdom Atomic Energy Authority. Reactor Group. Atomic Energy Establishment, Winfrith, Dorset, England). May 27, 1964. 23p. Dep.; $0.70(BIS), 3s. 6d. (HMSO).

The paper describes work on high-temperature ionization chambers suitable for in-pile measurements. The advantages of pulse transformers for use with pulse counters are discussed and an improved design is described. Results on fast pulse channels operating at counting rates up to 2×10^6 c/s are presented. Two d-c chambers are noted. The first, for operation at up to 400°C, is a $2\frac{1}{2}$" diameter, helium-filled, boron-coated device of sensitivity 2.6×10^{-14} amp/unit flux. The second, a $\frac{1}{4}$" diameter fission chamber was developed for work at temperatures up to 550°C and fluxes beyond 10^{13} nvt. (auth)

754 (AERE-R-4111) THE USE OF COBALT AS AN ACCURATE THERMAL NEUTRON FLUX MONITOR. N. K. Taylor and J. K. Linacre (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). July 1964. 40p. Dep.; $1.10(BIS), 5s. 6d. (HMSO).

A set of ^{60}Co counting standards was prepared using 0.010-in. diameter cobalt wires. Their activities were from 0.212 to 728 μC with a relative accuracy of ±2%, and an absolute accuracy of ±4%. The effective thermal-neutron activation cross section to be used with 0.010-in. diameter cobalt wire for BEPO irradiations was determined by direct comparisons with gold foils, calibrated using GLEEP as a neutron source. The value measured is 33.2 ± 0.7 barns, with an absolute accuracy of ±5%. This value agrees with the product of the bare atom activation cross section of 36.6 ± 1.5 barns and the appropriate self-shielding factor for wire of the dimensions used, in the BEPO neutron spectrum. The use of dilute alloys of cobalt in aluminium for the measurement of neutron fluxes was investigated, and it is shown that there is no significant self shielding. The bare atom cross section should therefore be used for this material. Factors for the correction of old data, derived using other standard sources and different effective cross sections, are given. (auth)

755 (AERE-R-4524) CALIBRATION OF A NEUTRON REM COUNTER. J. W. Leake and J. W. Smith (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). July 1964. 21p. Dep.; $0.60(BIS), 3s.(HMSO).

Measurements were carried out on a neutron counter assembly made up of a boron trifluoride proportional counter surrounded by polyethylene, with an intermediate perforated layer of high-density boron-loaded plastic. The neutron response of the counter was accurately determined at thermal energies and for the range 7 kev to 16 Mev. The response was shown to fit the U.K.A.E.A. code of practice, relating neutron fluence and dose equivalent, within ±15% over the neutron energy range 30 kev to 6 Mev. The response per rem for neutrons outside this energy range does not match the required curve quite so well, but it is still possible to achieve a response within ±50% of that required for a neutron energy range extending from thermal to 12 Mev. It is shown that the optimum dimensions of the various parts of the moderator system surrounding the BF_3 counter are critical for all neutron energies. The moderator components were made from solid blocks of polyethylene, and the optimum dimensions

required for a best fit to the required response characteristic were found to differ somewhat from those quoted by Andersson and Braun, who used a moderator system built up from thin polyethylene sheet. The dimensions quoted were adopted for the design of the A.E.R.E. Type 1940A neutron rem counter. (auth)

756 (BNL-8437) OPERATION AND CALIBRATION OF THE COSMOTRON RADIATION MONITORING SYSTEM. Internal Report. Allen S. Grossman (Brookhaven National Lab., Upton, N. Y.). Aug. 5, 1964. Contract AT-30-2-GEN-16. 19p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The design and calibration of the Cosmotron radiation monitoring system are described. The system uses 16 tissue-equivalent pulsed ionization chambers with transistor amplifiers and mechanical counters. The time interval between successive pulses of the chambers is set so that if the second pulse arrives while the timer is running, an alarm is sounded. (R.E.U.)

757 (CEA-R-2420) ETUDE THEORIQUE ET REALISATION D'UN SPECTROMETRE BETA ELECTROSTATIQUE SPHERIQUE. (Theoretical Study and Construction of a Spherical Electrostatic Beta Spectrometer). Roger Moret (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Grenoble). 1964. 77p. Dep.(mn).

Thesis submitted to Université, Grenoble, France.

A literature survey is presented showing the importance of an electrostatic spectrometer with spherical electrodes for studying disintegration processes. The theoretical characteristics of such an apparatus are derived (determination of the trajectory equations — calculation of the transmission and of the resolving power — the case of a point source and of an extended source). The apparatus built as a result of these calculations is described. The electrostatic field distribution outside the electrodes is derived. As well as giving electron spectra (β disintegration and conversion electrons) the apparatus makes it possible to study e-γ, e-β, e-e-γ, and e-e-β coincidences. Experimental characteristics and the results of the first measurements made on conversion electron spectra (^{161}Tb, ^{151}Pm, ^{152}Eu) and on coincidences (^{170}Tm) using this spectrometer are given. (auth)

758 (CEA-R-2503) ETUDE THEORIQUE POUR UN TRANSFEROMETRE DIGITAL. (Theoretical Study for a Digital Transfer Function Analyzer). Jacques Freycenon (France. Commissariat à l'Énergie Atomique. Centre d'Etudes Nucléaires, Saclay). 1964. 34p. Dep.(mn)

The study deals with the harmonic analysis of the instantaneous counting rate of a pulse train. This arises from using a fission chamber for reactivity-to-power transfer function measurements by oscillation methods in reactors. The systematical errors due to the sampling process are computed. The integration carried out when sampling the signal modifies the formulas of the Nyquist theorem on spectrum folding. The statistical errors due to the noise are analyzed: it is shown that the bandwidth of the spectral window applied to the noise frequency spectrum is equal to the inverse of the time duration of the experiment. A dead time of 25 per cent of the sampling time does not increase appreciably the bandwidth. A new method is proposed yielding very approximate results of the Fourier analysis during the experiment. The systematical errors arising from the measuring process are determined, and it is shown that the bandwidth of the corresponding spectral window is still given by the inverse of the time duration of the experiment. (auth)

759 (CTSL-41) SELECTIVE DETECTORS FOR HIGH-ENERGY PHOTONS AND ELECTRONS. Clemens A. Heusch and Charles Y. Prescott (California Inst. of Tech., Pasadena. Synchrotron Lab.). Jan. 29, 1964. Contract AT(11-1)-68. 33p. (CONF-417-32). Dep.(mn); $2.00(cy), 1(mn) OTS.

From American Physical Society Meeting, Pasadena, Calif., Dec. 1963.

For fast identification of high-energy electrons and photons in heavy backgrounds, a counter was developed consisting of successive layers of lucite and lead. Cherenkov radiation emitted in the lucite slabs is collected onto the photocathode of one 5-inch phototube. The geometry as well as the thickness of inserted lead converters can be adapted to kinematical requirements. At 1 Bev/c incoming momentum, the rejection ratio of e, γ showers vs π, or μ is better than 100:1; i.e., proper discrimination setting will allow rejection of 99% of all π's and μ's, while only 1% of e's and γ's will be lost. Protons make no pulses at all. The response over the face of the counter is uniform. The properties of the counter are checked in detail against the behavior of lead glass Cherenkov counters, and of lead scintillator sandwiches of comparable geometry. Many applications appear to favor this type of counter over others operating on conventional principles. (auth)

760 (DP-908) PROTOTYPE MONITOR FOR AIRBORNE IODINE AND FISSION PRODUCTS. Joseph W. Adams (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). July 1964. Contract AT(07-2)-1. 8p. Dep.; $1.00(cy), 1(mn) OTS.

The design is presented for a new system for monitoring gases from the dissolution of irradiated uranium in radiochemical separation processes at the Savannah River Plant. The system includes filter paper and activated charcoal to trap particulate activity and iodine vapor; as activity builds up, it is detected by a concentrically mounted G-M tube. Early operating experience is also discussed. (auth)

761 (GEAP-4643) A FULL-RANGE IN-REACTOR-CORE NEUTRON MONITORING SYSTEM EMPLOYING ION CHAMBERS. In-Core Instrumentation Development Program. Topical Report, Fiscal 1964. R. A. DuBridge and W. K. Green (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). June 1964. Contract AT (04-3)-189. 24p. Dep.; $1.00(cy), 1(mn) OTS.

An ion chamber system was developed, capable of covering the range of 10^4 to 5×10^{13} nv inside a reactor core for non-control applications at 550°F and high gamma fields. The system consists of two channels: a counting channel, and a Campbell or variance signal channel. Design features and performance characteristics are discussed. (R.E.U.)

762 (HW-79125) A DUAL PROBE PLUTONIUM MONITOR. E. M. Sheen, D. P. Brown, and J. Ryden (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Oct. 3, 1963. Contract AT(45-1)-1350. 7p. Dep.(mn); $1.00(cy), 1(mn) OTS.

In the production process for ^{239}Pu, it was desired to monitor the amount of ^{239}Pu in small metal cans prior to being reprocessed. The emitted 380-kev photons provide an indication of the ^{239}Pu quantity. A gamma spectrometer was developed for this application and is described. Operating instructions are also included. The ^{239}Pu monitor consists of dual scintillation probes with NaI(Tl) crystals, a holder for two processing cans, high-voltage supply, single-channel pulse-height analyzer, and count rate meter. The crystals are 2 inches in diameter by 2 inches long. The instrument sensitivity is such to provide detection of 2 grams of ^{239}Pu in the center of a 4-inch diameter by 5-inch long thin-wall can with approximately one inch of MgO absorber surrounding the ^{239}Pu. (auth)

763 (HW-81746(p.2.19-23)) PULSE SHAPE DISCRIMINATION IN FAST NEUTRON DOSIMETRY. L. L. Nichols and W. C. Roesch (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Most of the light energy liberated by neutrons in an organic scintillator can be detected and distinguished from that produced by gamma rays, but the ratio of the light emitted to the neutron dose is not independent of neutron energy. Methods of correcting for this are discussed. (auth)

764 (HW-81746(p.2.24-6)) RESPONSE OF PAIRED ION CHAMBERS AS A FUNCTION OF ENERGY. R. A. R. Kent (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Paired ion chambers, tissue-equivalent and tissue-equivalent minus hydrogen and nitrogen, were found to

possess responses as functions of energy for neutrons and photons, which make them suitable for personnel dosimeters in plutonium production facilities. (auth)

765 (HW-81746(p.2.27-8)) PRECISION LONG COUNTER INTERCOMPARISONS. J. DePangher and L. L. Nichols (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Comparisons of eight different precision long counters show they can be built to have sensitivities within about 0.5% of each other. One counter suffered a small change in sensitivity. (auth)

766 (HW-81746(p.2.41-3)) THEORY OF MEASUREMENT IN BEAMS. W. C. Roesch (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

The average dose rate in a beam of radiation smaller than an instrument was found to equal the integral of the readings of the instrument in a plane perpendicular to the beam divided by the cross sectional area of the beam. "Dose" is used to mean exposure, kerma, or (absorbed) dose for equilibrium conditions. (auth)

767 (HW-81746(p.5.46-53)) EXPERIMENTAL METHOD FOR MEASUREMENT OF NEUTRON DOSE. G. F. Garlick (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

A technique was investigated for the measurement of neutron dose and dose rates over a wide energy range. The objective was to achieve a composite response corresponding to that established by the National Committee on Radiation Protection (NCRP). Further, it was desired that the developed instrument be compact for direct personal use and also be applicable for use in general area neutron monitoring. The experimental multiple-detector neutron dosemeter showed promise in providing a measurement of neutron dose and dose rates over an energy range from thermal to 10 Mev. A composite sensor system using three solid state junction diodes as thermal, intermediate, and fast neutron energy detectors was developed. Response over the thermal to low kev range is provided by a ^{6}LiF cover over a diode plus a 3-in. diameter hydrogenous moderator. The intermediate range, from a low kev value to several hundred kev, is monitored by a ^{103}Rh foil covered diode plus a cadmium cover and suitable moderation. The fast neutron portion of the spectrum is measured through the use of a ^{238}U foil over the third diode. During the experimental tests, appropriate weighting functions were applied electronically by line-operated instrumentation to the signals from the three detectors. The composite response curve was determined through measurements with neutron sources, a Van de Graaff accelerator, and through specific calculations. Results indicated that a neutron dose of less than 1 mrem could be measured. (auth)

768 (HW-81746(p.5.54-8)) SIGNALING RADIATION DOSEMETERS. D. P. Brown (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Development was accelerated on personally carried, miniature, signaling radiation dosemeters, which employ a recharging type of ionization chamber as the sensor. The major effort concerned improving reliability and uniformity of response of the experimental dosemeters to provide a readily-apparent audible signal following accumulation of a predetermined dose. The effort centered around a single signal activation point, typically 50 or 100 mr. In addition, a number of solid-state circuit refinements were incorporated along with a method of correctly charging the center rod of the "pencil" type ionization chamber before use. Other work was directed at improving the recharging fiber and center rod mechanical assembly to achieve reliable performance. Several experimental dosemeters were assembled and tested with promising results and a model was fabricated for use in possible offsite fabrication procurement of a representative number of dosemeters. (auth)

769 (HW-83427) ENRICHMENT TESTER FOR 0.15 TO 3.0 WEIGHT PERCENT U^{235} URANIUM FUEL. C. N. Jackson, Jr. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). July 1964. Contract AT(45-1)-1350. 28p. Dep.; $2.00(cy), 1(mn) OTS.

A single channel analyzer and gamma scintillator system was developed to measure enrichment of the ^{235}U isotope in metallic uranium. The system uses a unique characteristic of the gamma decay of ^{235}U and ^{238}U to obtain a net activity proportional to the concentration of ^{235}U. The tester has been used in a routine operation to quickly and nondestructively assay enrichment of bare reactor fuel with 0.72 to 1.65% enrichment. The capability of the tester has been demonstrated for a range from 0.15 to 3.0 wt%. (auth)

770 (INSJ-78) A SIMPLE METHOD FOR EVALUATIONS OF THE ABERRATIONS DUE TO QUADRUPOLE-MAGNET SYSTEMS. Kohsuke Yagi (Tokyo Univ. Inst. for Nuclear Study). Aug. 22, 1964. 57p. Dep.(mn).

The third-order aberrations due to a quadrupole magnet and to a quadrupole-magnet doublet are formulated. First, trajectory equations for charged particles in a quadrupole magnet are derived to third order. The third-order terms arise from the following two sources: the variation of the longitudinal velocity as a result of the slope of the trajectory; and the existence of the longitudinal component of the magnetic field. The non-linear trajectory equations are solved by the successive approximation method. The solutions are then expressed by simple analytic functions to third order. The edge effect of the quadrupole magnet is taken into account by the use of the step function. By applying these solutions to a quadrupole magnet and to a quadrupole-magnet doublet, the formulas for the third-order aberrations are obtained. They are expressed by simple analytic functions of the parameters of the boundary conditions and the quadrupole-magnet system. From the general property of the symmetry with respect to the ray (optic) axis, there cannot exist the even-order terms in the aberrations. (auth)

771 (JINR-P-1810) RAZVITIE METODIKI ISKROVYKH KAMER. (Advances in Spark Chambers). A. A. Tyapkin (Joint Inst. for Nuclear Research Dubna, U.S.S.R.). 1964. 21p. (CONF-550-75). Dep.(mn).

From The International Conference on High-Energy Physics, Dubna, USSR, Aug. 1964.

A review is given of the performance and improvement of spark and gas discharge chambers. The treatment of spark chamber films and filmless techniques for spark chamber data are discussed as well as some optical methods of recording spark coordinates. The enumerated recordings of the spark position by sonic, electric, or optical processes are not suitable for recording traces of several particles and may be used only for measuring particle polarization. The conclusion was made that the photographic methods are the most efficient recording methods. (R.V.J.)

772 (LAL-1104) ETUDE DE CIRCUITS CORRECTEURS POUR UN SPECTROMETRE 1.3 Gev. (Study of Compensating Circuits for a 1.3-Gev Spectrometer). B. Boutouyrie and P. Fardeau (Paris. Universite, Orsay. Ecole Normale Superieure. Laboratoire de l'Accelerateur Lineaire). May 1964. 15p. Dep.(mn).

The correction of the variations of the "n" and "β" indices as a function of the induction, of a 1.3-Bev/c double focusing 180° spectrometer was studied. As corrections by static shims were insufficient, a system of current antenna arranged on the poles was calculated. The correction on "n" is completely independent of the correction on "β." (tr-auth)

773 (LAL-1114) TRACES ET PARCOURS D'ÉLECTRONS, MUONS ET PIONS DANS UNE CHAMBRE À ÉTINCELLES A PLAQUES ÉPAISSES. (Tracks and Course of Electrons, Muons, and Pions in a Spark Chamber With Thick Plates). J. E. Augustin, P. Marin, and F. Rumpf (Paris. Université, Orsay. Ecole Normale Supérieure. Laboratoire de l'Accélérateur Linéaire). Sept. 1964. 40p. Dep.(mn).

An experimental apparatus to be used for $e^{+}e^{-}$ collision

studies up to 600 Mev at the Orsay linac is described. A spark chamber with thick plates is used for the detection of electrons, muons, and pions. Particle tracks and ranges in the chamber are discussed. (R.E.U.)

774 (LAMS-3074) DETECTION OF NUCLEAR EXPLOSIONS IN SPACE INCLUDING DETECTOR INFORMATION FOR LAUNCH 2. (Los Alamos Scientific Lab., N. Mex.). Apr. 1964. Contract W-7405-eng-36. 57p. Dep.(mn); $3.00(cy), 2(mn) OTS.

The radiations emitted by a nuclear explosion in space are described. Detection of such explosions by ground-based, earth-satellite, and solar satellite systems is discussed, and the advantages and disadvantages of each are described. The far-earth orbit system was studied in more detail, and the characteristics of the radiation belt, meteoroid flux, solar wind, sunspots, etc., are described. Detailed descriptions are given of the following satellite detectors: model 4 x-ray detector, gamma-ray detector, neutron detector, XV detector, electron-proton spectrometer (PK detector), and magnetometer. The data required from the detectors on the background and significant events for telemetering to the ground are outlined. (D.L.C.)

775 (MITNE-47) FAST NEUTRON SPECTROSCOPY AND DOSIMETRY OF THE MIT REACTOR MEDICAL THERAPY FACILITY BEAM. Scientific Report No. 3. Roger A. Rydin, Norman C. Rasmussen, and Gordon L. Brownell (Massachusetts Inst. of Tech., Cambridge). May 1964. Contract AF19(604)-7492. 254p. (AD-602057; AFCRL-64-404). $4.00 (OTS).

The neutron spectrum in the M.I.T. Reactor Medical Therapy Facility Beam was measured using a combination of foil detectors. The absolute thermal flux was measured with gold foils using a β-γ coincidence counting technique; the epithermal spectrum was measured by taking cadmium ratios with three different resonance foil materials; and the fast neutron spectrum was measured with ten different threshold foil materials. The foil activation data were obtained by gamma-ray spectrum analysis and decay curve analysis. An ~4π scintillation counter with a 256 channel analyzer and multiscaler was used for this purpose. All data were taken relative to thermally activated standard reactions, which were related to the absolute thermal flux calibration. Decay curves for ^{28}Al and ^{27}Mg were analyzed using FRANTIC, an iterative, weighted, least-squares exponential growth and decay data fitting program. FRANTIC was also used to fit gross fission product decay curves from ^{237}Np, ^{238}U, ^{232}Th, and ^{235}U. The fast neutron spectrum was calculated from the threshold foil data using the Weighted Orthonormal and Weighted Orthonormal Polynomial Methods, which were coded for the IBM-7090 computer. These methods were extensively tested on exact data and on data from the ISPRA-1 Reactor. A composite neutron spectrum was constructed using the results of the fast, epithermal, and thermal flux measurements. This was used to compute the dose rate in tissue using Snyder's Monte Carlo results for a broad beam of neutrons. The calculated gamma-ray dose was then compared to experimental results. (auth)

776 (NP-14332) IMPROVED SOLID-STATE RADIATION DETECTOR. Final Report. M. S. Shaikh, R. R. Ferber, E. L. Keller, and P. R. Malmberg (Westinghouse Electric Corp. Semiconductor Div., Youngwood, Penna. and Westinghouse Electric Corp. Research Labs., Pittsburgh). Apr. 22, 1963. Contract OCD-OS-62-70. 151p.

An investigation of silicon diode structures as solid-state gamma radiation detectors, and recommendations for their utilization in OCD instrumentation are presented. The efforts are divided into five categories: (1). Theoretical studies and a mathematical analysis of gamma response for the determination of optimum detector parameters. This work was carried out using an IBM 7094 computer. (2.) Setting up diode production and evaluation facilities. This includes instrumentation for diode evaluation, gamma source preparation, diode diffusion and alloying furnaces, special vacuum evaporator facilities, lithium ion drifting apparatus and power supply. (3.) Development of diode formation processes including diffusion, alloying, ion drift, and combinations of processes. (4.) Fabrication and evaluation of diode structures, contacting, and encapsulations. (5.) Development of transistorized instrument electronics, i.e., ultralow noise preamplifier, amplifier, response compensation circuit, and metering circuit design. (auth)

777 (NRL-6145) PRESENT STATUS OF DOSIMETRY BY RADIOPHOTOLUMINESCENCE METHODS. F. H. Attix (Naval Research Lab., Washington, D. C.). July 7, 1964. 26p. Dep.(mn); $2.00(cy), 1(mn) OTS.

A review is presented of the present status of dosimetry by radiophotoluminescence and thermoluminescence devices, including: principles of operation, types of glasses or phosphors available, types of luminescence-measuring instruments, dose-ranges, precision and linearity obtainable, time-stability of dosimeter response, temperature effects during irradiation and storage, dependence upon absorbed dose rate, dependence of response per roentgen upon the effective quantum energy of γ radiation, response to neutrons, and dependence of response per rad upon linear energy transfer (LET). A brief historical review of each system is presented. Recent developments in infrared stimulable phosphors for dosimetry are also mentioned. A reference list of 97 items is given. (auth)

778 (ORNL-3676(p.47-8)) NEUTRON SCATTERING. (Oak Ridge National Lab., Tenn.).

The construction of the Triple-Axis Neutron Spectrometer Facility for the HN-4 beam hole at the ORR has been completed, and it is currently being assembled for operation. In addition to conventional neutron-scattering experiments of interest to solid state physics, the HN-4 facility was designed for inelastic neutron-scattering studies at various temperatures and applied magnetic fields. (auth)

779 (ORNL-3699) A MINIATURIZED FISSION CHAMBER AND PREAMPLIFIER ASSEMBLY (Q-2617) FOR HIGH-FLUX REACTORS. D. P. Roux, E. Fairstein, S. H. Hanauer, G. C. Guerrant, and J. L. Kaufman (Oak Ridge National Lab., Tenn.). Oct. 1964. Contract W-7405-eng-26. 17p. Dep.; $1.00(cy), 1(mn) OTS.

An articulated assembly consisting of a fission chamber, a preamplifier, and flexible cables was developed to meet the space and environmental requirements of high-flux reactors. This assembly, which has an in-service life greater than 1 year and low noise-pickup performance, is particularly suited as part of a reactor counting channel. The entire assembly is waterproof and can operate continuously at a temperature of 100°C. Its maximum outside diameter is $\frac{3}{4}$ in. and its maximum rigid length is 1 ft. (auth)

780 (ORNL-P-548) METHODS OF FAST-NEUTRON SPECTROSCOPY FOR REACTOR SHIELDING. F. C. Maienschein (Oak Ridge National Lab., Tenn.). [1964]. Contract W-7405-eng-26. 9p. (CONF-654-6). Dep.(mn); $1.00(cy), 1(mn) OTS.

From American Nuclear Society Meeting, San Francisco, Nov.-Dec. 1964.

Spectrometer types used for shielding studies in the fission–neutron range (<1 Mev) are discussed; the spectrometers depend on production of recoil protons, nuclear reactions in counters, activations with cross sections of known energy dependence, or on time-of-flight. (R.E.U.)

781 (PAN-516/II) POVERKHNOSTNO-BAR'ERNYE KREMNIEVYE DETEKTORY TIPA dE/dx. (dE/dx Surface-Barrier Silicon Detectors). T. Krogul'ski, Ya. Khvashchevska, and M. Yaskula (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). Apr. 1964. 13p. Dep.(mn).

The detectors obtained had thicknesses 70, 50, 40, 30, and 25 μ, the active area 1 to 1.5 cm^2 while their barrier could be broadened over the whole geometrical detector thickness. The detectors were studied by means of natural polonium and thorium α sources and by means of 24-Mev α particles and 12.7-Mev protons obtained from a cyclotron. (auth)

782 (SGAE-PH-5/1964) UNTERSUCHUNG DER ZEITAUFLÖSUNGSGRENZE VON SZINTILLATOREN SOWIE DEREN ANWENDUNG IN EINER NEUEN KOINZIDENZAP-

PARATUR. (Investigation of the Time Resolution Limits of Scintillators as well as their Use in a New Coincidence Apparatus). W. Bartl (Österreichische Studiengesellschaft für Atomenergie G.m.b.H., Seibersdorf, Austria). [1963]. 55p. Dep.(mn).

The time resolution of scintillation counters was studied so that it was clearly established that there is a point of smallest time scattering on the side of the scintillation pulse. The position of this point is dependent on the scintillation time constant. From this investigation, a detector system with a pertinent time-amplitude converter was designed so that all presently known effects were used. Both the state of the problem and the results obtained were completely reported. (tr-auth)

783 (TID-21194) MEASUREMENT OF THE RESOLUTION FUNCTION OF AN ANTHRACENE SCINTILLATION DETECTOR (thesis). Chun Woo Nahm (Pennsylvania State Univ., University Park). Mar. 1963. 45p. Dep.(mn); $2.00(cy), 2(mn) OTS.

The resolution functions of an anthracene scintillation detector were measured using monoenergetic K conversion electrons in the range 160 to 980 kev by use of a beta-x ray coincidence technique. The resolution function was found to consist of a Gaussian peak combined with a low-energy tail. An iteration method and the normalized resolution function were used to obtain a resolution correction for the ^{198}Au continuous beta spectrum and ^{137}Cs conversion line spectrum. (auth)

784 (TID-21234) A CHARGE-SENSITIVE PULSE PREAMPLIFIER WITH A FIELD-EFFECT TRANSISTOR INPUT STAGE. Scientific Report No. 11. R. E. Wintenberg and J. F. Pierce (Tennessee. Univ., Knoxville. Engineering Experiment Station). Oct. 15, 1963. For Oak Ridge National Lab., Tenn. Contract W-7405-eng-26, Subcontract 2160. 51p. Dep.(mn); $3.00(cy), 1(mn) OTS.

The application of a 2N2500 field-effect transistor in the input stage of a low-noise, charge-sensitive pulse preamplifier is demonstrated. This type preamplifier is used in conjunction with solid-state charged-particle detectors and multichannel analyzers. The techniques used in designing the preamplifier are explained in some detail. The performance characteristics of the preamplifier are compared with other transistor and vacuum tube units. This preamplifier is much better than bipolar transistor units and almost as good as the best vacuum tube preamplifier. (auth)

785 (UCRL-3307(Rev.2)) LAWRENCE RADIATION LABORATORY COUNTING HANDBOOK. (California. Univ., Berkeley. Lawrence Radiation Lab.). June 5, 1964. Contract W-7405-eng-48. 185p. Dep.(mn); $5.00(cy), 4(mn) OTS.

A compilation is presented of operational techniques and performance specifications on counting equipment. The counting notes are written from the viewpoint of the user. The equipment covered includes amplifiers, cables, coaxial components, coincidence systems, discriminators, amplitude analysis components, photomultipliers, scintillators, scalers, readout equipment, waveform generators, and power generators. (D.L.C.)

786 (UCRL-11384) THE 25-INCH LIQUID HYDROGEN BUBBLE CHAMBER. F. Barrera, R. A. Byrns, G. J. Eckman, H. P. Hernandez, D. U. Norgren, A. J. Shand, and R. D. Watt (California. Univ., Berkeley. Lawrence Radiation Lab.). May 25, 1964. Contract W-7405-eng-48. 37p. Dep.; $2.00(cy), 1(mn) OTS.

A 25-inch liquid-hydrogen bubble chamber, which incorporates into its design many improvements and several unique features, is described. Unique to the chamber is a movable top window that serves both as the piston for the liquid-expansion system and as an optical condenser lens. The motion of this window is controlled by a single-convolution bellows welded into the chamber perimeter; use of such a bellows avoids frequency-response problems common with multiconvolution bellows. Due to the action of this top window, turbulence is virtually eliminated because no liquid either enters or leaves the chamber. The aspherized condenser lens system is believed to be approximately five to ten times more efficient than any installed in earlier machines of this size. Fewer ghost reflections appear, more uniform bubble tracks are observed, and greater simplicity of operation is achieved. A scattering angle of 12° improves photographic uniformity in depth and avoids the need for individual light sources for each stereo lens. The chamber combines a high degree of precision with a rapid operating cycle. At present the chamber can be operated twice during each Bevatron pulse, thus doubling the number of pictures taken. A conventional water-cooled magnet provides a vertical field of 18.5 to 22.8 kilogauss. (auth)

787 (UCRL-11620) MAGNETOSTRICTIVE READOUT FOR "WIRE SPARK CHAMBERS." Victor Perez-Mendez and James M. Pfab (California. Univ., Berkeley. Lawrence Radiation Lab.). Aug. 21, 1964. Contract W-7405-eng-48. 19p. Dep.; $1.00(cy), 1(mn) OTS.

The signals generated in a wire spark chamber are magnetically coupled to a single readout lead for each chamber plane using a thin nickel ribbon magnetized to a suitable bias level. The ribbon is in close proximity to the chamber wires so that the magnetic field of the spark current that flows through any wire of the chamber to a common ground lead is coupled to the nickel ribbon. Since nickel is magnetostrictive, the magnetic field pulse produces a local elongation of the ribbon in the immediate vicinity of the chamber wire. One end of the ribbon is located within a pickup coil where the Villari effect produces a millivolt signal. Spark position is obtained from the time interval between onset of the discharge and output pulse from the pickup coil. The performance of the magnetostrictive delay-line readout is discussed. (R.E.U.)

788 (USAELRDL-TR-2397) WIDE-RANGE SCINTILLATION DETECTOR FOR AERIAL RADIOLOGICAL SURVEY. Joseph C. Nirschl and Frank C. Genovese (Army Electronics Research and Development Lab., Fort Monmouth, N. J.). Aug. 1963. 37p. (AD-601092) $1.00(OTS).

The report describes the development of an aerial radiac set utilizing a scintillation detector and log pentode converter. The evolved circuitry of the aerial radiac set is completely transistorized, except for the miniature log converter tube (Nuvistor). The aerial radiac set accepts the signal from a radar altimeter for automatic altitude correction. It features a presettable alarm, a telemetry output, and a chart recorder. The dynamic range of the instrument is four decades (0.01 to 100 R/hr.); the detector speed of response is less than 0.1 second. A regulated power supply permits operation off the 28-volt aircraft supply. (auth)

789 MORE SENSITIVE, MORE RELIABLE INSTRUMENTS TO DETECT AND MEASURE RADIATION. Atomics, 17: 10-16; 19-20; 22-3(Sept.-Oct. 1964).

Developments in radiation-detection instrument technology are reviewed. Improvements in survey instruments, counting-room instruments, emergency instruments, personnel monitors, and whole-body facilities are outlined. Aspects such as education, training, servicing, repair, and design and manufacture trends are summarized. (T.F.H.)

790 AUTOMATIC APPARATUS FOR CONTINUOUS MEASUREMENT OF THE RADIOACTIVITY OF ATMOSPHERIC DUSTS. F. Baracchi, G. Magnoni, P. Zaniol, and F. Zuanni (Università, Modena, Italy). Atti. Soc. Nat. Mat. Modena, 94: 53-60(1963). (In Italian)

An automatic apparatus for the continuous measurement of the radioactivity of atmospheric dusts is described. The dust is collected on an Al ribbon by means of an electrostatic precipitator, and the activity is measured with a G-M counter. The daily activity is recorded by means of a complex that totals the decays detected by the counter. The amplifier circuit and recording and drive circuits are described, and the operational sequence of the apparatus is reported. (J.S.R.)

791 60-INCH BUBBLE CHAMBER AT CERN. CERN Courier, 4: 120-3(Sept. 1964).

The design of the 60-in. bubble chamber at CERN is presented. The expansion system, refrigerator, photography, the electromagnet, controls, hydrogen safety, chamber cooling, and the operating cycle are discussed. (C.E.S.)

792 THE ABSORPTION PARAMETERS OF ANNIHILATION PHOTONS IN SCINTILLATORS. J. Kajfosz (Inst. for Nuclear Research, Czechoslovakia Academy of Sciences, Rez). Cesk. Casopis Fys., 14: 401-10(1964). (In Czech)

Expressions are given for the probability of absorption in cylindrical scintillators of both, one, or no photons from the two-quantum annihilation of a positron inside the scintillator. The values of these parameters are given for NaI and CsI scintillators of various dimensions, obtained by calculation on a mathematical machine. (auth)

793 DESIGN OF A β SPECTROMETER WITH TROCHOIDAL TRAJECTORY USING COILS WITHOUT IRON. Daniel Mugnier and Joseph Lafoucrière Institut de Physique Nucleaire, Lyon). Compt. Rend., 259: 1098-1101(Aug. 3, 1964). (In French)

The fabrication of a β spectrometer, using trochoidal trajectories in a symmetrical induction with r^{-1} revolution, with coils without iron has a major obstacle: the achievement of the desired topography in a region of space large enough so that the luminosity and resolution characteristics of the device will not be limited. A method is proposed that makes it possible for the induction to be aligned to 6% on a region comprised between the radii r_1 and r_2 so that $r_2/r_1 = 2.5$. (tr-auth)

794 INVESTIGATION OF CdS PULSE CURRENT INDUCED BY α-PARTICLE ANODE IRRADIATION. K. Kirov and M. Kaltsova. Compt. Rend. Acad. Bulgare Sci., 17: 5-8(1964). (In Russian)

A detailed study was made of the pulse current induced by ionization of the crystal near the anode. The production and characteristics of the CdS crystal are outlined. The crystals were irradiated on one side with Po α particles. A typical pulse shape for α range less than the crystal thickness is shown; the leading edge of the pulse consists of a fast part, determined by the circuit time constant, and a slow part independent of the circuit. The variations of the two parts of the leading edge on particle penetration into the crystal at room temperature, on voltage at room temperature and penetration of 4.5×10^{-4} cm, and on temperature at penetrations of 16 and 12×10^{-4} cm are given. (M.J.T.)

795 CALCULATIONS OF RANGE SPECTRA OF HARD-COMPONENT COSMIC PARTICLES IN A CYLINDRICAL SPECTROMETER. V. Zlatarov. Compt. Rend. Acad. Bulgare Sci., 17: 19-22(1964). (In Russian)

To a first approximation, the differential momentum spectrum of the hard component of cosmic particles leaving a scintillation counter can be used to calculate the range spectrum in the scintillator. Expressions for the four components of the range spectrum are derived. (M.J.T.)

796 THE FEASIBILITY OF USING A LUMINESCENCE SPECTROMETER TO STUDY THE GAMMA RAYS FROM THE (n, GAMMA) REACTION. A. P. Bogdanov and E. I. Firsov. Dokl. Akad. Nauk Belorussk. SSR, 8: 376-8 (1964).

A luminescence spectrometer with a NaI(Tl) crystal was added to the system used in a channel tangential to the reactor core to study the gamma-rays emitted in thermal neutron capture. The luminescence spectrometer was used to supplement the magnetic spectrometer and improved the performance of the system by increasing the resolution and attenuating the gamma background. The instrument combines a 70×70 cm crystal with a photomultiplier, has a ^{137}Cs-line resolution of 13%, and allows the isotope sample to be reduced to 30 to 40 g. Pulses from the multiplier are sent into a multichannel amplitude analyzer provided with an automatic spectrum tape recorder. The gamma beam from the isotope sample being studied is shaped by collimators set in the channel, passes through the vacuum chamber of the magnetic spectrometer, and reaches the crystal. (OTS)

797 COUNTING STATISTICS AND DEAD-TIME LOSSES. PART 1. I. De Lotto (CNR-CISE, Milan), P. F. Manfredi, and P. Principi. Energia Nucl. (Milan), 11: 557-64(Oct. 1964).

After a general mathematical formulation of the counting problems, particular cases are studied. For each case, general functions which characterize the output distribution are given. Many of these functions are original. Moreover, asymptotic expressions of counting losses are obtained. (auth)

798 AN ATOMIC BEAM MAGNETIC RESONANCE APPARATUS FOR SHORT-LIVED ISOTOPES. G. K. Rochester and K. F. Smith (National Inst. for Research in Nuclear Science, Harwell, Berks, Eng.). J. Sci. Instr., 41: 629-32(Oct. 1964).

An atomic beam magnetic resonance apparatus was built to measure the spins and moments of radioactive nuclei, produced by neutron capture, having half lives (t) as short as approximately half a minute. It was used to study ^{66}Cu (t = 5.2 min) and ^{108}Ag (t = 2.3 min), and could be applied to any isotope with a half-life greater than 15 seconds, formed in a solid sample from an isotope with a sufficiently large abundance and slow neutron capture cross section. (auth)

799 A THREE-DIMENSIONAL TRACK SIMULATOR. M. B. M'Clements Lambie (Univ. of Glasgow). J. Sci. Instr., 41: 643-4(Oct. 1964).

A device that simulates the track of a particle in a cloud chamber is described. It was originally made to analyze difficult tracks near the axis of the stereoscopic cameras, and subsequently found useful for all tracks. (auth)

800 SIGNIFICANT PROGRESS FOR GAMMA SPECTROSCOPY: LITHIUM DRIFTED GERMANIUM COUNTERS. M. Roemer and H. Schneider (Universität, Giessen, Ger.). Kerntechnik, 6: 421(Sept. 1964). (In German)

Performance of lithium-drifted germanium counters in gamma spectroscopy is discussed. Results are compared with NaI(Tl) scintillation counters for ^{60}Co gamma spectra. (M.C.G.)

801 MILLIMICROSECOND TIME-TO-PULSE HEIGHT CONVERTER. Lajos Almasi and Laszlo Sandor. Magy. Tud. Akad. Kozp. Fiz. Kut. Int. Kozlemen., 12: 299-312(1964). (In Hungarian)

Problems in connection with the design and testing of a millimicrosecond time-to-pulse-height converter are discussed, and the system is described. Investigating possible conversion systems, in view of the given scope of measurements and specification requirements, the start-stop principle proved to be the most suitable as compared with the pulse overlap, vernier, and differential converter systems. The circuit arrangements, and the role and function of each block are described. Tests and calibration of the converter were performed on a millimicrosecond basic test set and 128 channel pulse height analyzer for scintillation signals. (auth)

802 MICROWAVE SPECTROMETER FOR ANALYTICAL USE AND ITS APPLICATION TO THE ANALYSIS OF DEUTERATED PROPYLENE. Yonezo Morino and Eizi Hirota (Tokyo Univ.). Nippon Kagaku Zasshi, 85: 535-8 (Sept. 1964). (In Japanese)

A conventional Stark-modulation spectrometer was modified to adapt it to the quantitative intensity measurement. First, a pair of ferrite isolators were put in front of and behind the absorption cell so as to prevent multiple reflection of the microwave in the absorption cell. Second, a precise step attenuator was inserted in the detection and amplification circuit. Any nonlinearity in the circuit was eliminated by recording two lines to be compared as equal in height as possible by means of the attenuator. The abundance ratio of ^{37}Cl to ^{35}Cl was measured to be 0.319 ± 0.017, which agreed well with the value 0.326 given in the literature. The rotational lines used were the $3_{13} - 2_{12}$ transitions of the gauche form of allyl chloride. The spectrometer was used to determine the relative abundance of deuterated propylene in the sample, which was obtained by exchanging hydrogen atoms of normal propylene with deu-

terium atoms of deuterium oxide absorbed on metal catalyzers such as nickel and palladium. The results were much more precise and detailed than those obtained by other analytical methods. The spectrometer can also be used to determine the frequencies of low-frequency vibrations such as torsional oscillation. (auth)

803 OVERLOADING PULSE AMPLIFIER. R. Conrad and T. Friese (Hahn-Meitner-Institute für Kernforschung, Berlin). Nucl. Instr. Methods, 30: 203-5(Nov. 11, 1964). (In German)

A nonoverloading transistorized pulse amplifier designed for the use with proportional counters is described. The recovery time is less than 0.5 μsec after an overload of 1000. The input sensitivity is 1 mv and can be attenuated to 3, 10, 30 and 100 mv with an input resistance of 1 kohm. The thermal drift of the threshold is less than 2% between 0 and 50°C. The output delivers positive (0/+6v) and negative (0/−6v) unit pulses with an output resistance of 100 ohm; the pulse duration is 120 nsec. (auth)

804 PULSE HEIGHT DISTRIBUTION OF ELECTRONS INCIDENT ON PLASTIC SCINTILLATORS. V. J. Vanhuyse, K. J. Van Camp, and J. L. Bourgoignie (Rijksuniversiteit, Ghent). Nucl. Instr. Methods, 30: 209-12(Nov. 11, 1964).

The pulse-height distribution of monoenergetic electrons (0.4 to 1.4 Mev) incident on 0.10 to 0.40 cm thick plastic scintillators was studied using a ^{32}P source and a double-focusing 120° spectrometer. In some cases, two peaks were observed, the place and height of which depended on the electron energy and the thickness of the scintillator. A theoretical interpretation of this behavior is given and compared with experiment. The agreement is good. (auth)

805 REVISED THEORY OF TIME RESOLUTION IN SCINTILLATION COUNTERS. E. Gatti and V. Svelto (CISE, Milan). Nucl. Instr. Methods, 30: 213-23(Nov. 11, 1964).

The problem of the statistical limits in the accuracy of time measurements with scintillation counters is theoretically analyzed by the Monte Carlo method; results useful for slow scintillators are obtained. Furthermore, some errors regarding previous works are corrected and a more direct approach for calculating "machine time" variances, for the general case, is introduced. Final graphs for estimating time resolution, as a function of the scintillator time constant and taking into account the statistical properties of the phototube specified by transit time fluctuations, by a finite width response to a single photoelectron and by gain fluctuations, are included. (auth)

806 THE SUPER RESOLUTION OF GAMMA-RAY SPECTRUM. T. Inouye (Tokyo Shibaura Electric Co.). Nucl. Instr. Methods, 30: 224-8(Nov. 11, 1964).

A method for analyzing mixed gamma spectra using Fourier transforms were developed. The resolving power of the spectrometer was notably increased by use of this method, and the small energy difference between two gamma rays from ^{95}Zr was successfully determined. (D.C.W.)

807 THE QUADRUPOLE TRIPLET MAGNET AS A MOMENTUM SPECTROMETER. J. S. O'Connell, R. C. Morrison, and J. R. Stewart (Yale Univ., New Haven). Nucl. Instr. Methods, 30: 229-36(Nov. 11, 1964).

The solid angle of a source of charged particles through a quadrupole triplet magnet to a detector is calculated. The effects of source size, magnet aperture, and detector size on the momentum dependence of the transmission solid angle are investigated. The momentum resolution needed to use the magnet in conjunction with a detector as a mass analyzer is also considered. (D.C.W.)

808 A PULSE SHAPE DISCRIMINATOR FOR PARTICLE SEPARATION AND PILE-UP SUPPRESSION. R. Bass, W. Kessel, and G. Majoni (Johann-Wolfgang-Goethe-Universität, Frankfurt am Main). Nucl. Instr. Methods, 30: 237-44(Nov. 11, 1964).

The double delay-line clipped pulses from a DD2 amplifier show a zero crossover point which is constant within $\sim 2 \times 10^{-9}$ sec for a wide range of pulse amplitudes. Changes in the risetime of the input pulses due to different decay times of signals produced by particles with different ionization densities in a scintillation crystal result in a change of the zero crossover time. The same effect will take place due to pile-up of two pulses. The bipolar output pulses of the amplifier are analyzed in two channels: one for the positive going part of the pulses, another for the negative one. In both channels discriminators prevent triggering by suprious pulses. A variable delay of high resolution in the first channel brings the two output pulses to coincidence for a certain risetime of the detector pulses. A Garwin circuit detects the fast coincidence. The resolution of the coincidence is controlled by an output trigger stage, which delivers signals for the gate of a multi-channel analyzer. With (n,p) and (n,α) reactions produced by neutron bombardment of KI(Tl) and NaI(Tl) scintillation crystals, appreciable pulse shape discrimination was obtained. Pulse height spectra showing pulse shape discrimination and pile up suppression are given, and the circuit is described. (auth)

809 TRACK RECOGNITION IN IONIZATION CHAMBERS BY MEANS OF AN ANALOG COMPUTER. R. Benoit, C. Koechler, and L. Stanchi (Euratom, C. C. R., Ispra, Italy). Nucl. Instr. Methods, 30: 252-8(Nov. 11, 1964).

An instrument which permits evaluation of an expression of the type $(a - b)/c^n$, where all the quantities are represented by electric pulses, is described. The calculation is made by converting the quantities into the logarithm. The logarithms are processed and are converted into the original quantities by an exponential operation. The application to an ionization chamber in order to obtain a track collimation of the alpha particles independently of the energy is discussed. (auth)

810 A SPECIAL ABSORBER METHOD FOR REDUCING THE EFFECTS OF GAMMA RAYS IN THE SPECTRA OF GAMMA-SENSITIVE BETA DETECTORS. J. Kantele, O. J. Marttila, and A. Pakkanen (Univ. of Helsinki). Nucl. Instr. Methods, 30: 259-60(Nov. 11, 1964).

A modification of the conventional absorber method in reducing the effects of gammas in the beta spectra of gamma-sensitive beta detectors is described. The system presented comprises a rotating circular absorber disk with sector-shaped holes. The disk also controls the store mode of a multichannel analyzer, so that the electron and gamma pulses are stored when no absorber is imposed, while the gamma pulses are subtracted when the absorber section is between the source and the detector. These two modes of operation are associated with different phases of a revolution. The system rejects most of the gamma pulses automatically and is particularly useful in the study of short-lived activities. (auth)

811 A VERSATILE SCALER AND READ-OUT SYSTEM. H. G. Jackson, L. B. Robinson, and D. L. Wieber (Univ. of California, Berkeley). Nucl. Instr. Methods, 30: 261-7(Nov. 11, 1964). (UCRL-11303)

A scaling system is described the automatic readout of which can record from an unlimited number of scalers or other digital equipment. The readout system normally controls a paper-tape punch at 60 characters per second or a typewriter at 15 characters per second, but magnetic-tape output has also been used. The scaler has a dead time per count of less than 100 nsec. Nixietube display is provided, and a wide range of operating modes are possible. Planar silicon transistors and diodes are used exclusively in both the scaler and the read-out. (auth)

812 A METHOD TO CONSTRUCT THE SUM SPECTRA FROM SCINTILLATION DETECTORS. P. O. Tjoem (Universitet, Oslo). Nucl. Instr. Methods, 30: 287-9 (Nov. 11, 1964).

A method for constructing the sum spectrum from scintillation detectors is proposed, and measurements of the high-energy gamma transitions in the decay $^{214}Bi - ^{214}Po$ are described. (auth)

813 THE DETERMINATION OF BACKGROUNDS FOR NEUTRON TIME-OF-FLIGHT SPECTROMETERS. O. D. Simpson, R. G. Fluharty, M. S. Moore, N. H. Marshall, F. B. Simpson, G. E. Stokes, T. Watanabe, and T. E.

Young (Phillips Petroleum Co., AED, Idaho Falls, Idaho). Nucl. Instr. Methods, 30: 293-7(Nov. 11, 1964).

A technique for determining the time-dependent backgrounds associated with low-energy neutron time-of-flight spectrometers is described. Mathematical equations are presented showing how the backgrounds can be determined from transmission measurements through boron filters. A detector-scattered background, which consists of neutrons scattered by the detector, somewhat moderated by the surroundings and subsequently detected, is also discussed. Data from neutron transmission measurements of water, carbon and cobalt are presented which demonstrate that backgrounds are measured adequately. (auth)

814 DISCRIMINATION DEPENDENCE OF A PHOSWICH SYSTEM ON THE INTEGRATING TIME CONSTANT. R. L. Crawford (Los Alamos Scientific Lab., N. Mex.) and A. Erteza. Nucl. Instr. Methods, 30: 303-5(Nov. 11, 1964).

The theoretical maximum ratio of pulse heights from fast and slow scintillation phosphors in a phoswich system is degraded by the transit time spread of the photomultiplier and the integrating time constant of the output circuit. A mathematical treatment is presented to obtain the ratio of the pulse heights from general equations that are developed. The results of this analysis for a typical phoswich consisting of a plastic scintillator and a CsI(Tl)-crystal show that for each photomultiplier transit time spread there is an optimum integrating time constant. Graphs are included to show the relative pulse heights and the time spread between the fast and slow voltage pulses as a function of the integrating time constant. (auth)

815 DEPENDENCE OF EFFICIENCY OF A COINCIDENCE TRITIUM COUNTER ON PHOTOCATHODE SENSITIVITY. V. A. Pethe and D. B. Sangodkar (Atomic Energy Establishment, Trombay, India). Nucl. Instr. Methods, 30: 306-8(Nov. 11, 1964).

An effort is made to correlate the cathode sensitivities of the photomultipliers in a coincidence liquid scintillation counter with its efficiency for tritium counting. The efficiency increases with the product of the cathode sensitivities until it tends to become asymptotic to a theoretical maximum value. In an attempt to explain this in terms of the number of electrons released from the photocathode, it is found that the number of photo-electrons emitted by the cathode varies linearly with the cathode sensitivity. However, efficiency of the scintillator, geometry and light losses set a limit to this number and hence to the efficiency of the counter. (auth)

816 EXCITATION INDUCED BY α PARTICLES IN THE RARE GASES IN THE PRESENCE OF AN ELECTRIC FIELD. J.-L. Teyssier, D. Blanc, J. Brunet, and A. Godeau (Université, Toulouse). Nucl. Instr. Methods, 30: 331-5 (Nov. 11, 1964). (In French)

The effects of gas pressure and of an electric field on scintillation in rare gases traversed by alpha particles were studied. The effect of the electric field on the height, width, and rise time of pulses in the detector specifically were considered. The amplifying effect of the electric field was attributed to an electron mechanism; the effect was used to observe scintillation in air excited by alpha particles from ^{239}Pu. (D.C.W.)

817 A SCINTILLATION CHAMBER-IMAGE CONVERTER SYSTEM FOR SPACE EXPERIMENTS. J. R. Waters (American Science and Engineering Inc., Cambridge, Mass.). Nucl. Instr. Methods, 30: 336-40(Nov. 11, 1964).

A detector which is especially suited to nuclear experiments in space is described, consisting of a track-imaging filament scintillation chamber coupled to an image converter tube of high gain that has direct electrical read-out. Its application to two typical experiments—a gamma telescope to detect high-energy photons and an experiment to measure the angular distribution of protons and electrons in space—is described. (auth)

818 THEORY OF SHOWER γ-SPECTROMETERS. V. F. Grushin and E. M. Leikin (Lebedev Inst. of Physics, Moscow). Nucl. Instr. Methods, 30: 341-7(Nov. 11, 1964).

A method of applying the results of the theory of branching processes to the calculation of the main characteristics of shower gamma spectrometers is presented. Expressions for the energy resolution and instrumental line shape are obtained. (auth)

819 A TWIN COUNTER FOR LOW-LEVEL BETA DETECTING. H. Lindeman and J. Shamir (Israel Inst. of Tech., Haifa). Nucl. Instr. Methods, 30: 348-50(Nov. 11, 1964).

A counting system for measuring soft, low-level beta activities is described, consisting of two disk-like Geiger-Mueller counters separated by a very thin silver window and shielded by a guard counter of similar shape. Even without shielding material, the background is only about 3 cpm. (D.C.W.)

820 SOME CONSIDERATIONS ON COUNTING STATISTICS. I. De Lotto (CISE Labs., Milan), P. F. Manfredi, and P. Principi. Nucl. Instr. Methods, 30: 351-4(Nov. 11, 1964).

Relations for determining the time distribution of the output of counting systems involving paralyzable and nonparalyzable counters, scalers, and combinations are presented. The effects of dead time and the counting losses are examined. (D.C.W.)

821 A NOTE ON THE NON-PROPORTIONAL RESPONSE OF NaI(Tl) CRYSTALS TO GAMMA RAYS. M. L. Verheijke (Gloeilampenfabrieken, Eindhoven, Netherlands). Nucl. Instr. Methods, 30: 357-8(Nov. 11, 1964).

The nonproportionality of the light output to the gamma energy was confirmed by calibrating the energy axis of spectra with known gamma energies. A single-channel spectrometer incorporating an automatic logarithmic step attenuator was used. An approximation for the energy calibration in the range from 10 kev to about 3 Mev was proposed. (D.C.W.)

822 A DIGITIZED MULTI-WIRE SPARK CHAMBER FOR HANDLING MANY PARTICLES. S. Miyamoto (Osaka City Univ.). Nucl. Instr. Methods, 30: 361-2(Nov. 11, 1964).

A spark chamber with two pairs of wire electrodes is proposed for determining the tracks of several particles. The theoretical bases of the arrangement are outlined. (D.C.W.)

823 EFFECT OF THE NON-LINEAR RESPONSE OF NaI(Tl) CRYSTAL ON POSITRON-ELECTRON PAIR SUMMING SPECTRA. T. Tomimasu and S. Sugiyama (Electrotechnical Lab., Tokyo). Nucl. Instr. Methods, 30: 363-4 (Nov. 11, 1964).

Electron pair summing spectra were measured using a two-crystal scintillation spectrometer, and the scintillation response (light output/Mev as a function of energy) of a NaI(Tl) crystal to electron pairs and gamma rays was obtained. In the low-energy range, the scintillation response to the former is considerably larger than that for the latter at the same energy; but there is little difference in the high-energy range. (D.C.W.)

824 USE OF Au 20% Pd FOR METALLISING THIN SOURCE SUPPORTS FOR 4π PROPORTIONAL GAS FLOW COUNTERS. G. C. Lowenthal and A. M. Smith (Australian Atomic Energy Commission, Research Establishment, Lucas Heights, New South Wales). Nucl. Instr. Methods, 30: 365-6(Nov. 11, 1964).

It was found that source supports of relatively low surface density and electrical resistance can be obtained by evaporation of a thin layer of Au–Pd onto a VYNS film. (D.C.W.)

825 A DETERMINATION OF THE CADMIUM ABSORPTION OF RESONANCE NEUTRONS IN CADMIUM-COVERED INDIUM FOILS. J. E. Powell and J. V. Walker (Texas Agricultural and Mechanical Univ., College Station). Nucl. Sci. Eng., 20: 476-80(Dec. 1964).

Theoretical and experimental determinations of the cadmium correction factor F_{Cd} have been made for various thicknesses of indium foils in an isotropic epithermal neutron flux. It was found that for indium foils with 0.040-in. cadmium covers F_{Cd} varied slightly with foil thickness and reached a maximum value of 1.123 for thicknesses greater than 90 mg/cm^2. (auth)

826 THE EFFECT OF FLUX ANISOTROPY OF NEUTRON-DETECTOR FOILS. G. R. Dalton (Univ. of Florida, Gainesville) and R. K. Osborn. Nucl. Sci. Eng., 20: 481-92(Dec. 1964).

An integral form of the one-speed neutron-transport equation is applied to the case of a neutron-detecting foil placed in a homogeneous medium with an initially non-isotropic neutron population. A series of numerical calculations is carried out to investigate the effect on the self-shielding flux-depression factor of anisotropy in the initial undisturbed flux. The case of a square foil of gold placed in a light-water medium is investigated. It is found that the existence of anisotropy in the initial flux leaves the flux correction factor essentially unchanged. However, the presence of anisotropy implies spatial non-uniformity of the scalar flux. Thus, movement of the center of mass of a foil in a flux which has a gradient, or rotation of a foil in a flux which has a second derivative can alter the undisturbed flux and the disturbed flux to which a foil is exposed, though the flux correction factor remains unchanged. (auth)

827 OPTIMUM TIME OF MEASURING ACTIVITY IN PRESENCE OF UNKNOWN BACKGROUND. I. NONSIMULTANEOUS MEASUREMENTS OF THE SAMPLE AND BACKGROUND. L. Jurkiewicz and S. Sterlinski. Nukleonika, 9: 697-703(1964). (In Russian)

The rational choice of time for measuring radioactive decay in the presence of an unknown background is discussed. Optimum time of measurement leading to minimum statistical relative error depends on the time of measuring background and the ratio of intensities of the source at the beginning of the measurement and the background. Mathematical formulas were developed and on this basis graphs are given indicating the relation between the optimum time of measurement and these parameters. Two cases are discussed: the time of measuring background is known before the measurement of the source is started; and the total time of measurement of the source and the background is preset. (auth)

828 SEMICONDUCTOR RADIATION DETECTORS. Hisanobu Kobayashi. Radioisotopes (Tokyo), 13: 323-8 (July 1964). (In Japanese)

The theory and characteristics of semiconductor radiation detectors are reviewed. The singular properties examined include the energy distribution, linearity of the output wave height with respect to the energy of the incoming particle, and the pulse build-up time. The operating characteristics of pulse ionization chambers, proportional counters, G-M tubes, scintillation counters and semiconductor detectors are compared, describing in detail three types of semiconductor detectors: the surface barrier, p-n junction, and p-i-n junction types. (TTT)

829 AN IMPROVED AUTOMATIC SCANNER FOR THE QUANTITATIVE EVALUATION OF BIDIMENSIONAL RADIOCHROMATOGRAMS. Marco Frank. With an Addendum on Its Performance by E. B. Chain, F. Pocchiari, and C. Rossi. Rend. Ist. Super. Sanita, 23: 893-905(1960). (In Italian)

An improved model of a previously described electronic automatic scanning device for the quantitative evaluation of bidimensional radiochromatograms is presented. The radiochromatograms are scanned between two Geiger counters for set time periods, line after line, and the number of pulses per time unit of exploration recorded, in positions corresponding to those of the radioactive spots on the radiochromatograms, on a blank sheet of paper inserted into the carriage of an electrical typewriter the number keys of which are actuated by a series of solenoids through an electronic read-out. In the present model the frame for carrying the paperchromatogram across the Geiger counters is eliminated. The paper chromatogram is simply fixed with scotch tape to the white paper sheet in the carriage of the electrical typewriter so that it is moved across the two Geiger counters by the typewriter carriage itself. The Geiger counters are smaller than in the previous model and fixed to the back of the typewriter. The whole apparatus consists of one single unit, comprising the electric typewriter with the solenoids actuating its number keys, the Geiger counters, the Dekatron scaler, the program unit and the read-out. Apart from the solenoids there are no mechanical or electromechanical parts in the scanner. The timer unit is entirely electronic and allows the setting of the minimum scanning time at any integral number of seconds between 10 and 100. Some improvements in the circuit of the program unit were also made. (auth)

830 DEVICES FOR THE DETECTION OF ENERGETIC PARTICLES. J. A. Newth (Imperial Coll. of Science and Tech., London). Rept. Progr. Phys., 27: 93-159 (1964).

A brief survey of some of the problems of high-energy particle physics is followed by a discussion of the properties of particle accelerators and the production and handling of beams of particles. The performance of four main types of particle detectors—scintillation and Cherenkov counters, bubble and spark chambers—is then described in some detail. A number of different detectors that are less common and important are briefly described. The capabilities and limitations of the different types of instruments are emphasized. 90 references. (D.C.W.)

831 APPARATUS FOR RELATIVE MEASUREMENTS OF GAMMA ACTIVITIES, PROVIDED WITH 4π IONIZATION CHAMBER (WELL TYPE). J. Cohen, M. Oncescu, and Fl. Rebigan (Inst. of Atomic Physics, Bucharest). Rev. Roumaine Phys., 9: 479-86(1964).

A 4π ionization chamber (well type) for secondary calibrations of the gamma sources is described. The performances and the advantages of the apparatus are presented. The comparative accuracy of standardization is 1%. (auth)

832 SPARK CHAMBER SYSTEM FOR HIGH ENERGY γ-RAY DETECTION. C. Calvelli (Università, Padua and Instituto Nazionale di Fisica Nucleare-Sizione, Padue), P. Kusstatscher, L. Guerriero, et al. Rev. Sci. Instr., 35: 1642-6(Dec. 1964). (MIT-2098-50)

An iron plate spark chamber is described. It covers $\frac{3}{4}$ of the solid angle about a liquid hydrogen target. The fifty steel plates (750 × 750 × 2 mm), separated by 3 mm, furnish a thickness of 5 radiation lengths. The voltage rise-time of the plates is less than 10 nsec. The system was used in a 250,000-picture experiment. (auth)

833 SECONDARY EMISSION MONITOR AS A LINEAR ACCELERATOR ELECTRON BEAM DOSE MONITOR. C. J. Karzmark (Hammersmith Hospital, London). Rev. Sci. Instr., 35: 1646-52(Dec. 1964).

The secondary electron emission monitor (SEM) is useful for monitoring electron beams at high dose rates since it is a vacuum device and free of the saturation problem encountered with ionization chambers. In the SEM, the current associated with secondary electrons ejected from a thin foil is collected and used to monitor the electron beam. A description is given of a SEM unit that exhibits a desirable voltage saturation characteristic and good linearity with beam current. The SEM current is about 0.035 of the transmitted beam current for a single aluminum collecting foil located between adjacent polarizing foils. The SEM is basically a current monitor, but for a scattered electron beam of constant incident energy a unique relationship exists between SEM current and the absorbed dose rate at a specified point in the radiation field. However, if the energy varies by only a few percent, the relationship between SEM current and the dose rate is greatly altered. Errors of 20 to 50% were encountered with a particular linac before the beam energy stability was improved. These errors are primarily due to a variation in scattered electron intensity stemming from the energy dependent nature of the scattering process, but also to the dependence of secondary electron yield on beam energy. The change in dose rate arising from the energy-dependent aspect of scattering is similar to that occurring in bremsstrahlung production under appropriate conditions. Over a beam energy range of about 1 to 600 Mev, the variation of yield with beam energy is similar to that for electron stopping power. By improving the energy stability of a particular linear accelerator the variation in dose monitor calibration was reduced to a few percent; an improvement by a factor of about 10. The ef-

fects of voltage changes, beam loading, and temperature are discussed. In the accelerator described, the microwave power was recirculated. By servo controlling the phase of the feedback power, improvement in energy stability was achieved. (auth)

834 FLUOROMETER FOR CHEMICAL DOSIMETRY. G. E. Berlinguette and P. A. Tate (Defence Chemical Biological and Radiation Labs., Ottawa). Rev. Sci. Instr., 35: 1725-6(Dec. 1964).

A filter fluorometer system is described for determining radiation-produced salicylic acid in calcium benzoate solution. Means used for light filtering and shielding in the system are shown. The sensitivity of the system in dosimetry is 6.3 nA/rad. The performance of this system is in the same order of magnitude as that of a grating spectrophotofluorometer. The filter fluorometer may also be used, with somewhat less precision, to determine radiation-produced hydroxyterephthalic acid in terephthalic acid–NaOH solutions. (T.F.H.)

835 A γ-γ ANGULAR CORRELATION SPECTROMETER WITH FOUR DETECTORS. Kurt Fricke, Friedrich Muennich, and Ullrich Wellner (Technische Hochschule, Brunswick). Z. Instrumentenk., 71: 277-83(1963). (In German)

The statistical analysis of the method used in angular correlation measurements shows that it is preferable to take data only at 3 different angles (180, 90, and 45 or 135°). Using this fact a $\gamma\gamma$-angular correlation device with 4 detectors was developed, in which time-dependent drifts in the electronic parts can be eliminated quantitatively. This apparatus and the method used for the evaluation of the final results are described. (auth)

836 A METHOD OF MEASURING A NEUTRON STREAM BY MEANS OF NUCLEAR EMULSION PLATES. Henryk Malecki, Krystyna Maluszynska, and Kazimierz Niedzwiedziuk. Zeszyty Nauk. Univ. Lodz., Ser. II, No. 9, 89-104(1961).

A method for obtaining the angular distributions of energetic and scattered neutrons using nuclear emulsion plates is described. (D.C.W.)

837 ELEMENTAL COMPOSITION OF NUCLEAR EMULSIONS. L. P. Vakhtanova. Zh. Nauchn. i Prikl. Fotogr. Kinematogr., 9: 129-31(Mar.-Apr. 1964). (In Russian)

Tabulated data for 24 sets of BP type, 5 sets of P type, and 7 sets of BK type emulsion showed the errors in determining silver halide concentration, density, humidity, and general indices. Comparisons of BP and G-5 emulsions conditioned at φ = 58 and 20% showed a recent increase in the content of silver halide in the BP. Comparisons of BR, G-5, and NTB conditioned at φ = 58 and 20% revealed only a small difference in the silver halide contents of BR and G-5; with G-5 having a slightly increased content of iodide and sulfur and a reduced content of nitrogen. The NTB emulsions have a lower content of halide than the BP and G-5 and contain no iodide. (R.V.J.)

838 PHYSICAL METHODS IN RADIATION CHEMISTRY AND IN RADIOBIOLOGY. John W. Boag. p.1-70 of "Actions Chimiques et Biologiques des Radiations. Sixieme Serie." Paris, Masson et Cie Editeurs, 1963.

The primary physical methods used in radiation chemistry and radiobiology are described. Pulse radiolysis, flash spectroscopy, electron spin resonance spectroscopy, solid-state dosimetry, and measurement of oxygen concentration in gases or liquids are discussed. In addition to a presentation of the principles of each method, the physical apparatus and its limitations are considered. 91 references. (J.S.R.)

839 REGULIROVKA I ISPYTANIYA MNOGOKANAL'NOI IZMERITEL'NOI APPARATURY DLYA YADERNOI FIZIKI. (Control and Test of Multichanneled Measuring Devices in Nuclear Physics). S. S. Kurochkin, ed. Moscow, Gosatomizdat, 1963. 180p.

Sixteen articles are presented on the basic characteristics, control, testing, and operation of multichannel measuring devices. (R.V.J.)

840 INVESTIGATIONS WITH GLASS DOSIMETERS AT A HIGH-VOLTAGE X-RAY UNIT. U. Proesch (Inst. of Applied Isotopic Research, Berlin). p.453-62 of "Radiation Chemistry." Budapest, Publishing House of the Hungarian Academy of Sciences, 1964.

Glass dosimetry for use in working with high-voltage x-ray equipment is discussed. Lead glass slides changed from colorless to yellow-brown under irradiation. Freshly irradiated slides showed a linear increase of extinction up to 170 kr. There was a strong fading effect. A green chromium glass changed color to brown-grey under irradiation. The response of the glass was dependent on radiation energy. The fading effect was less than 1% in a month. A dark blue cobalt glass became red under irradiation. Data for all the glasses are presented in graphs. (M.C.G.)

841 DESIGN CONCEPTS FOR A MINIMUM WEIGHT, HIGH RESPONSE TRACKING, TELEMETRY, AND INSTRUMENTATION SYSTEM TO MONITOR HIGH ALTITUDE NUCLEAR EXPLOSIONS. Lester Turner (Philco Corp., Newport Beach, Calif.). New York, Instrument Society of America, 1964, Preprint 1.1-3-64, 12p. (CONF-701-7)

From Instrument Society of America 19th Annual Instrument-Automation Conference and Exhibit, New York, Oct. 1964.

The possibility of gathering high-response data during a flight through a high-altitude nuclear explosion was studied. The instrumentation and communications requirements are particularly severe for this mission due to the very high radiation environment, the highly ionized atmosphere, and the wide information bandwidth. Two feasible tracking, telemetry, and instrumentation (TTI) systems, basically consisting of an integrated C-Band transponder, medium and high response data recorders, and a pulse-code-modulated telemeter, were configured. (auth)

842 APPARATUS FOR MEASUREMENT OF NUCLEAR RADIATION WITH A PHOTOMULTIPLIER. (to Harshaw Chemical Co.). German Patent 1,168,575. Apr. 23, 1964. Priority date Sept. 4, 1959, United States.

A phosphor-phototube radiation detector is described. It consists of a photomultiplier tube, a main phosphor for measurement of the radiation and a luminous standard prepared by mixing a suitable phosphor with a radioactive material. The luminous standard is optically coupled to the main phosphor. In order to shield the main phosphor from the radiation of the standard, the standard is coated with a light-transparent but nuclear-radiaton-absorbing layer of epoxy resin. (Gmelin Inst.)

843 AN IONIZATION CHAMBER DOSIMETER. René Schlaeppi (to Landis and Gyr AG). German Patent 1,169,041. Apr. 30, 1964. Priority date June 9, 1960, Switzerland.

In the dosimeter shell a wound capacitor, a discharge electrode, and a movable charging contact are arranged. The capacitor is wound on a conductive carrier tube, having one coat conductively connected to this tube. Projecting into the cavity of the tube, forming the actual ionization chamber, is an electrode fixed to the bottom of the shell, which in turn is conductively connected to the other capacitor coat. The electrode is flat and recessed. A leaf spring engages the recess and contacts the carrier tube on the inside in its deflected state projects from the other side into the tube cavity. This spring is fixed to a contact pin, which, in an insulated manner, is extended through the bottom of a shell-like charging device. It is fitted into the shell and seals the ionization chamber. The cavity of the charging device that is open to the outside is sealable to be dust-tight and water-proof. (Gmelin Inst.)

844 EQUIPMENT (SCANNER) FOR IMAGE REPRESENTATION OF THE DISTRIBUTION OF RADIOACTIVE MATERIAL IN A SPATIAL UNIT. Cuno Winkler. German Patent 1,171,094. May 27, 1964. Filed Oct. 31, 1957.

The photoscanner described consists of a scintillation counter, a rate meter, and a light source reproducing perfectly the motion of the counter. The intensity of the light source (u) is a function of the pulse rate (i). A feature of the invention is that the rate meter is connected via electronic control means to the light source. These control means serve for contrast enhancement by controlling con-

tinuously the parameters of the function u = f(i). (Gmelin Inst.)

845 GEIGER-MÜLLER COUNTING TUBE. Raymond Morgan. German Patent 1,171,541. June 4, 1964. Filed Aug. 7, 1959.

A halogen-quenched Geiger-Mueller counting tube is described. It consists of two metallic electrodes coated with a layer of titanium dioxide impermeable by the filling gas. By use of this coating corrosion of the electrodes is avoided. (Gmelin Inst.)

846 METHOD FOR THE SIMULATION OF NUCLEAR RADIATION DETECTORS. Werner Hasselbeck (to Telefunken Patetverwaltung GmbH). German Patent 1,171,542. June 4, 1964. Filed June 4, 1960.

Nuclear radiation was simulated by a high-frequency emitter and detectors were simulated by high-frequency receivers located at the site of the detectors. The energy of the high-frequency emitters was modulated with a noise voltage having statistically distributed amplitude values. The demodulator was connected to a pulse-height discriminator so that only pluses exceeding the threshold setting of the discriminator were received by the pulse shaping network (multivibrator) at the exit of the receiving network. (Gmelin Inst.)

847 ARRANGEMENT FOR PICTORIAL REPRODUCTION OF THE SURFACE RADIOACTIVITY DISTRIBUTION IN OBJECTS, FOR EXAMPLE, IN HUMAN BODIES. (to Frieseke and Hoepfner GmbH). German Patent 1,171,543. June 4, 1964. Filed Apr. 15, 1961.

An automatic scanning device, provided with a magnetic recording tape, which serves as a magnetic storage unit, is described. The magnetic head moves synchronously with the counter. Means are provided for the reproduction of the magnetically stored picture and for contrast enhancement. (Gmelin Inst.)

Radiation Effects

Refer also to abstract 1006.

848 (AD-601457) RADIATION EFFECTS ON GUIDED MISSILE ELECTRONIC EQUIPMENT. Final Technical Report, July 15, 1963–January 15, 1964. J. E. Bell (Hughes Aircraft Co., Fullerton, Calif.). Contract NOw-63-0486-d. 271p. (FR-64-17-41) $4.00(OTS).

Included in this investigation are: (1) electron and gamma correlation and a definition of the laboratory environment; (2) radiation effects on thin film devices, bulk semiconductor integrated devices and circuits, silicon controlled rectifiers, resistors, and the correlation of transistor response with electrical parameters; (3) general circuit hardening techniques, and the development of a silicon controlled rectifier equivalent model for radiation prediction techniques; and (4) radiation effects on nonlinear circuits employing silicon controlled rectifiers, four layer diodes, trigisters, and gate turnoff switches. (auth)

849 (FDL-TDR-64-30) EFFECTS OF NEUTRON AND GAMMA-RAY SPECTRA ON FLIGHT CONTROL SYSTEMS. Period Covered: January 1963–March 1964. Alvin B. Kaufman, Harry R. Newhoff, and Richard A. Gaz (Litton Systems, Inc., Woodland Hills, Calif.). Feb. 1964. Contract AF33(657)-10584. 137p. (AD-435603). $10.50 OTS.

The program encompassed theoretical and experimental tasks in which neutron and gamma ray spectra, dose rate, and neutron-gamma ratios were studied to determine their relative importance in predicting radiation damage to flight control systems in nuclear environments of advanced aerospace vehicles. Six different nuclear facilities were utilized for the radiation tests. Three of the reactors were steady state and three were pulse type. Each reactor produced a distinct spectrum and dose rate signature which was as fully defined as the state of the art permits. The empirical phase of the program was performed with 18 transistor gyro preamplifiers. These were divided into sets of three and each set was tested at 55°C in one of the six reactors. In addition, and concurrently, eight field effect transistors were exposed in each environmental test, inasmuch as insignificant permanent damage to the amplifiers was expected in the pulse irradiations and this otherwise would limit the extent of spectra-damage comparison. The analytical and empirical program has developed equations and constants that, within certain limitations, may be used to predict the life of flight control components or systems in advanced nuclear system environments. The performance of the components and systems tested and an analysis of the performance relative to reactor spectra and other environmental parameters are presented. (auth)

ISOTOPE TECHNOLOGY

General

850 (ORNL-3676(p.159-61)) SOLID STATE DIVISION'S ^{60}Co AND ^{137}Cs GAMMA SOURCES. J. W. Cleland and L. C. Templeton (Oak Ridge National Lab., Tenn.).

Data on temperature and dose rates are given for the three gamma sources. (auth)

851 RADIOACTIVE SOURCES FOR MEASUREMENT AND INSTRUMENTATION. Atomics, 17: 25-7 (Sept.-Oct. 1964).

Alpha, beta, gamma, heat, and neutron sources using radioisotopes are described. The procedures for obtaining, handling, and using these sources are outlined. (T.F.H.)

852 A CELL FOR THE SMALL SCALE ELECTRODEPOSITION OF RADIOACTIVE METALS. P. M. Dryburgh (Univ. of Glasgow). J. Sci. Instr., 41: 640(Oct. 1964).

A small glass apparatus is described that is suitable for electroplating from volumes of electrolyte solution of 1 ml, or less, at temperatures up to 100°C. This was used for the preparation of a 14.4 kev γ-ray source from carrier-free ^{57}Co solution. (auth)

853 CHEMICAL AND RADIOCHEMICAL CONTROL OF RADIOACTIVE ISOTOPES IN MEDICINE. Jelisavka Cvoric, Rade Draskovic, Dusanka Nemoda, and Branko Prokic ("Boris Kidrich" Inst. of Nuclear Sciences, Belgrade). Tehnika (Belgrade), 19: 822-6(1964). (In Serbo-Croatian)

The criteria for biological, chemical, and physical control of radioisotopes used in medicine are discussed. Controls for radioactive solutions of ^{198}Au, ^{131}I, ^{32}P, ^{59}Fe, and ^{51}Cr are described. (P.C.H.)

854 RADIOAKTIVNYE IZOTOPY KAK GAMMA-IZLUCHATELI. (Radioactive Isotopes Used as Gamma Emitters). N. G. Gusev, V. P. Mashkovich, and B. V. Verbitskii. Moscow, Atomizdat, 1964. 280p.

A review is given of the principal data on γ radioisotopes. Gamma constants were calculated using corrected electron conversion coefficients. A new x-ray equivalent of 87.7 erg/g instead of the previously accepted 85 erg was calculated. (R.V.J.)

855 INDUSTRIAL PARTICIPATION IN NUCLEAR ENERGY. OPPORTUNITIES AND OBSTACLES. p.72-96 of "Proceedings of the Tenth Anniversary Conference of the Atomic Industrial Forum." New York, Atomic Industrial Forum, 1964.

The activities and development of the nuclear industry in 1963 are summarized, and some aspects of commercial production and distribution of radioisotopes are discussed. The performance of SNAP-7 generators for terrestrial uses is summarized, together with the predicted characteristics of future terrestrial SNAP generators. The Marine Products Development Irradiator is briefly described. (D.C.W.)

Industrial Applications

856 (LA-DC-6570) A BETA SCATTER MATERIAL TESTER FOR INSERTION IN SMALL-DIAMETER BORES. B. L. Blanks (Los Alamos Scientific Lab., N. Mex.). [nd]. Contract W-7405-eng-36. 12p. Dep.(mn); $1.00(cy), 1(mn) OTS.

A probe containing a beta source and scatter-detection element was designed and constructed for measuring coating thickness on the inside surface of small-diameter bores (0.030 to 0.200-inch-dia). The performance of the probe is discussed. (R.E.U.)

857 (PDL-42574) BIBLIOGRAPHY ON RADIOACTIVE ISOTOPES AS TOOLS FOR DETERMINING SMALL CHANGES IN COMPOSITION AND STRUCTURE OF MATERIALS. PDC Search No. 61-038. (National Research Council. Prevention of Deterioration Center). Dec. 1961. 6p. (AD-601287). $1.10(OTS).

A total of 31 references is presented on a wide variety of tracer and radiometric applications of radioisotopes. (D.L.C.)

858 CONTROL OF THE DISCHARGE APPARATUS OF A SETTLING MACHINE BY A RADIOISOTOPE. Dietrich Bartelt and Helmut Bierwolf. A E G Mitt., 53: 421-30(1964). (In German)

Coal can not be sold in the form in which it is transported. It is mixed with rocks and coalesced matter, from which it must be separated. This separation can take place in a settling machine. The discharge apparatus of the settling machine was therefore controlled in dependence on the height of the separation layer. The separation layer height was determined previously by flotation. This method has several disadvantages. Better results can be produced when the separation layer is determined using radioisotopes. (tr-auth)

859 WEAR RATES IN AUTOMOTIVE ENGINES BY LIQUID SCINTILLATION COUNTING OF Fe^{55}. H. H. Ross, R. P. Gardner, and J. W. Dunn, III (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng., 20: 521-6(Dec. 1964).

A radiotracer technique for determining wear rates of selected automotive engine parts is described and demonstrated for piston rings. The technique uses ^{55}Fe instead of ^{59}Fe as the radiotracer. A liquid scintillation method for counting ^{55}Fe is necessary since it decays by electron capture and emits only the Mn characteristic x-ray of 5.9 kev. A simple method for extracting the wear particles from the engine oil and getting the iron into the liquid scintillation mixture is described. Counting yields of 8 to 9% are obtained by the method. The ^{55}Fe technique of wear measurement does not directly compete with the existing ^{59}Fe technique since slightly lower sensitivity and longer sample preparation is required. However, the much longer half life (2.6 years as compared to 45 days) and the lower radiation energy (5.9 kev as compared to over 1 Mev) of ^{55}Fe allows the ^{55}Fe technique to be used for long-term wear studies, for double tracer studies, and for studies of large engine parts. (auth)

860 USES OF ISOTOPES AND RADIATION. Nucleonics, 22: No. 10, 106-8(Oct. 1964).

A summary is given of the Geneva Conference papers on the uses of radioisotopes and radiations and the genetic effects of radiation. (C.E.S.)

861 USES OF RADIOISOTOPES IN CHEMICAL ENGINEERING. Kunitaro Kawazoe and Yasushi Takeuchi. Seisan-Kenkyu, 14: 165-71(May 1962). (In Japanese)

Uses of radioisotopes in control of mechanical separations, flow control, and control of materials transport are reviewed. The applications discussed include those in particle size determination, precipitation, filtration, centrifugation, mixing, flow control, liquid phase determinations, distillations, gas absorption, liquid-liquid extractions, drying, and adsorption. (M.C.G.)

862 PROPERTIES AND APPLICATION OF RECLAIMED RUBBER PRODUCED FROM IRRADIATED OLD MOTOR TIRES. W. Zieliński (Inst. of Nuclear Research, Warsaw). p.307-13 of "Radiation Chemistry." Budapest, Publishing House of the Hungarian Academy of Sciences, 1964.

The possibilities of using high-energy radiation for reclaiming rubber from old tires were studied. Rubber samples were irradiated in air by gamma rays with an average intensity of 110 r/sec. In addition to deterioration

of mechanical properties, cross-linking and degradation were observed. The irradiated cellulose-cord crumbled forming a homogeneous mixture with milled rubber. This mixture can be easily mixed with the components used as ingredients for rubber compounding in the rubber industry. (M.C.G.)

Power Application

863 (SC-R-64-1301) MICROWATT RADIOISOTOPE ENERGY CONVERTERS. W. F. Windle (Sandia Corp., Albuquerque, N. Mex.). Apr. 1964. Contract AT(29-1)-789. 6p. (CONF-768-1). Dep.(mn); $1.00(cy), 1(mn) OTS.

From International Conference on Aerospace Electro-Technology, Phoenix, Ariz., Apr. 1964.

After a survey of proposed radioisotope conversion systems this paper presents in detail two systems particularly suited for microwatt power sources; first, a 10^{-9} ampere ^{85}Kr β current cell capable of tens of kilovolts now in limited production is presented, followed by a discussion of other possible future β current cells. Second, some theoretical considerations of a ^{147}Pm silicon electronvoltaic converter with an output in the range of 100 μamp/cm^2 at a few tenths of a volt are discussed. Some applications adapted to each system are also presented. (auth)

Separation and Production

864 (CEA-Bib-47) METHODES DE SEPARATION DES ISOTOPES DU CARBONE. (Methods for Separating Carbon Isotopes). Rene Ranc (France. Commissariat a l'Energie Atomique. Centre d'Etudes Nucleaires, Saclay). Aug. 1964. 38p. Dep.(mn).

This literature review includes 76 references and covers the period from 1932 to 1962. The majority of the current separation methods have been used in the case of carbon isotopes (^{12}C and ^{13}C). They are classified into two groups: methods based on a difference in the physical properties (fractional distillation, thermal diffusion, gaseous diffusion) and methods based on a difference in the chemical properties (isotopic exchange reactions and resin chromatography). This work leads to the following conclusions: the techniques capable of leading to a semi-industrial application are essentially: the fractional distillation of carbon monoxide, and the hydrocyanic acid-cyanide ion chemical exchange. The method of diffusion across an auxiliary gas will no doubt soon join the preceding ones; thermal diffusion is interesting for preparing very rich mixtures from a product whose ^{13}C content has previously been enriched by another method; furthermore, it is very widely used for increasing the ^{14}C content of natural mixtures when age measurements are being carried out. (auth)

865 (ORNL-3679(p.23-38)) ISOTOPE CHEMISTRY. (Oak Ridge National Lab., Tenn.).

Selectivity and diffusion coefficients were determined for Li^+ and Na^+ in anhydrous solution with Dowex 50-X1, -X8, and -X16 ion exchange resins, and with ethylenediamine as the solvent. Li isotopic separation factors were determined as a function of eluant concentration in ion exchangers Zeo-Karb and Dowex 50 with HCl as the eluant, and in Dowex 50 with ammonium acetate as the eluant. In each case the separation factors decreased as the concentration increased. Studies were made of the exchange of B between BF_3 (gas) and the liquid BF_3 coordination complexes of Et_2O, Et_2S, Et_3N, and THF. Isotopic equilibrium constants and thermodynamic functions characterizing these reactions were obtained. New adducts useful in the separation of B isotopes were sought. BF_3 and BCl_3 were added to thiophenol, diphenyl sulfide, diphenyl methyl amine, NN-dimethyl aniline, and methyl isocyanide. The resulting molecular addition compounds are described. The single-stage separation factors for $^{13}C/^{12}C$ and $^{18}O/^{16}O$ were determined for diethylamine carbamate and n-propylamine carbamate in equilibrium with an excess of CO_2 at the boiling point of the respective carbamates. It was shown that the C isotope separation factors for these systems are strongly temperature dependent but relatively insensitive to the molecular weight or degree of branching of the constituent amine. Operation of the Oxygen-17 Facility continued without major interruptions during the period. Currently, peak concentrations of ^{17}O and ^{18}O are 4.3 and 99.6%, respectively. Isotopically enriched water valued at more than $70,000 was placed in inventory. The N_2 isotope effect in the decomposition of aryl diazonium ion, $ArNN^+$, to N_2 is 1.0531 at 6.9, 1.0451 at 40.5, and 1.0426 at 68.5°C. The fundamental frequencies for the ^{14}N and ^{15}N species of $C_6H_5NNBF_4$ are 455/451, 533/526, and 1152/1139 cm^{-1}. The predicted isotope effects for decomposition of diazo salts are 1.0389 at 6.9°C, 1.0352 at 40.5°C, and 1.0327 at 68.5°C. The single-stage separation factor for K isotopes in the system aqueous metal hydroxide–metal amalgam was determined to be 1.0006 ± 0.0004 for ^{39}K and ^{41}K. The heavy isotope concentrates in the aqueous phase. A CsF pellet pressed at 55 tsi was found to transmit in the infrared with no cutoff evident out to 250 cm^{-1}. The rate of exchange of BF_3 between $(C_2H_5)_2O \cdot BF_3$ and $C_6H_5OCH_3 \cdot BF_3$ in a mixture of $(C_2H_5)_2O$, $C_6H_5OCH_3$, and BF_3 was found to follow the rate law $R \simeq k_1[(C_2H_5)_2O \cdot BF_3]\,[C_6H_5OCH_3 \cdot BF_3] + k_2[(C_2H_5)_2O \cdot BF_3]\,[C_6H_5OCH_3]$. In a mixture containing $(C_2H_5)_2O$, tetrahydrofuran, and BF_3, a similar expression plus a third term, $k_3[(C_2H_5)_2O]/[(C_2H_5)_2O \cdot BF_3]$, is needed to fit the experimental data. In completely complexed mixtures of BF_3, $(C_2H_5)_2O$, and a second ether or thioether, the stronger the second BF_3 complex, the slower is the BF_3 exchange between the two addition compounds. Nuclear magnetic resonance data are given for ClF_5 and $FClO_2$. All the fundamental vibrational frequencies of the chloryl fluoride (ClO_2F) molecule were observed in the Raman spectra. The Cl_2 and O_2 isotopic structures of many of the fundamental, overtone, and combination bands were resolved. Valence force constants were calculated which closely reproduce the observed fundamental frequencies and their isotopic shifts. The infrared and Raman spectra of the square pyramidal molecules $XeOF_4$, IF_5, BrF_5, and ClF_5 were recorded, and valence force constants were calculated. The remarkable resemblance between the Xe compound and the interhalogen compounds is pointed out. Thermodynamic functions were computed for the isotopic reaction occurring when light and heavy water are mixed. Excess functions for liquid mixtures of the isotopic forms of water were also derived. (auth)

866 (ORNL-tr-335) A METHOD FOR CONCENTRATING AND RECOVERING HEAVY WATER FROM CONCENTRATED MOTHER LIQUOR OF SEA WATER. Tadashi Watanabe. Translated for Oak Ridge National Lab., Tenn., from Japanese Patent 19252/1963. Apr. 7, 1961. 6p. Dep.(mn); $1.10(fs), $0.80(mf) JCL.

A method is given for concentrating and collecting D_2O from sea water concentrate which already has been concentrated in D_2O by previous evaporations, e.g., bittern. The method is based on first salting-out the salts of Mg, Ca, or Na with water of crystallization from the concentrate, and then separating the water of crystallization from the hydrated crystals. The method results in water enriched in D_2O to an extent as high as 100% compared to tap water. An example of the application of the method is given. (D.L.C.)

867 STABLE ISOTOPE SEPARATION. I. PRINCIPLES AND METHODS. C. U. Linderstroem-Lang (Atomenergikommissionens Forsogsanlaeg, Riso, Denmark). Dansk. Kemi., 43: 118-24(1962). (In Danish)

The general principles of stable isotope separation are presented and their application to the many possible processes is described. An attempt is made to provide a simple classification scheme that clearly exposes important similarities between processes; in doing so some modification to the system usually adapted has been necessary. (auth)

868 APPLICATION OF α-HYDROXYISOBUTYRIC ACID TO THE SEPARATION OF SOME METAL IONS ON THE ION-EXCHANGER KU-2. Ignacy Stroński and Andrzej Zieliński (Inst. of Nuclear Physics, Krakow). Nukleonika, 9: 801-7(1964). (In Polish)

The radioisotopes of ^{7}Be, ^{90}Y, ^{89}Sr, ^{95}Zr, ^{95}Nb, ^{160}Tb, ^{171}Lu, ^{181}Hf, ^{182}Ta and ^{233}Pa were used in the studies of the conditions of the separation of mixtures of some elements on the strong acidic ion-exchanger KU-2 by means of α-hydroxyisobutyric acid. The preparation of radiochemically pure carrier-free radioisotopes of ^{7}Be, ^{90}Y and ^{95}Nb is described. (auth)

869 ISOTOPE ENRICHMENT IN Ca, Pb, AND Cd BY IONIC MIGRATION IN MOLTEN IODIDES. J. Romanos and A. Klemm (Max-Planck-Institut für Chemie, Mainz). Z. Naturforsch., 19a: 1000-5(July-Aug. 1964). (In German)

The cation mass effect $\mu_+ = (\Delta b_+/b_\pm)/(\Delta m_+/m_+)$ (Δb_+ = mobility difference of the cation isotopes, $b_\pm$ = mobility of the cations relative to the anions, $\Delta m_+ = m_1 - m_2$, and $2m_+ = m_1 + m_2$) in pure molten salts was calculated. The results obtained were: CaI_2 (880°C), $\mu_+ = -0.0745 \pm 0.003$; PbI_2 (600°C), $\mu_+ = -0.0731 \pm 0.005$; and CdI_2 (580°C), $\mu_+ = -0.0764 \pm 0.003$. All three salts form, in the solid state, laminated lattices and show relatively large mass effects, in qualitative (not quantitative) agreement with a rule on the relation of mass effect and lattice type. (tr-auth)

MATHEMATICS AND COMPUTERS

Refer also to abstracts 339, 1054, and 1837.

870 (HW-81173) CONTOUR PLOTTING BY ANALOG COMPUTER. R. A. Harvey (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Mar. 4, 1964. Contract AT(45-1)-1350. 4p. Dep.(mn); $1.00(cy), 1(mn) OTS.

An analog diagram is shown for display of a function representing a steady-state process, e.g., $f(x,y,z) = (x-5)^2 + (y+x)^2 + (z-y-x)^2 + 10$. (R.E.U.)

871 (JINR-P-1739) OB ASIMPTOTICHESKOM POVEDENII MOMENTOV CHISLA POYAVLENII REKURRENTNOGO SOBYTIYA. (On the Asymptotic Behavior of the Moments of the Number of Appearances of a Recurrent Event). A. Obretenov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). 1964. 7p. Dep.(mn).

A problem encountered in the theory of recurrent events is solved; the asymptotics of the moments of the number of appearances of the recurrent event whose mean recurrence time is finite or infinite is given. The case of infinite recurrence time has some physical applications. (auth)

872 (KAPL-M-6194) DPT—A FORTRAN PROGRAM FOR THE SOLUTION OF FIRST ORDER COUPLED DIFFERENTIAL EQUATIONS OF THE DEPLETION TYPE. Dario Bollacasa and D. T. Goldman (Knolls Atomic Power Lab., Schenectady, N. Y.). Aug. 31, 1964. Contract W-31-109-eng-52. 17p. Dep.(mn); $1.00(cy), 1(mn) OTS.

DPT is a FORTRAN computer program which solves a system of coupled first order differential equations whose general form can be written as

$$\frac{dNi(t)}{dt} = \sum_{j=1}^{n} M_{ij}\, N_j(t), \text{ for } i = 1, 2, \ldots, n.$$

The technique used in the solution is discussed. Typical applications are briefly mentioned. (auth)

873 (LA-3106(Vol.I)) TABLES OF THE NUMBER OF BINARY DECOMPOSITIONS OF ALL EVEN NUMBERS $0 < 2n < 200{,}000$ INTO PRIME NUMBERS AND LUCKY NUMBERS. M. L. Stein and P. R. Stein (Los Alamos Scientific Lab., N. Mex.). July 1964. Contract W-7405-eng-36. 442p. Dep.; $7.42 (OTS).

Tables are presented giving the number of decompositions of all even numbers $0 < 2n < 200{,}000$ into (a) two odd primes and (b) two lucky numbers. Subsidiary tables are included which give certain statistical and enumerative data based on the primary tables. For the prime case ("Goldbach decompositions"), a probabilistic model is given by which the Goldbach curve can be fitted with satisfactory accuracy over the range considered. (auth)

874 (NYO-1480-4) THE STABILITY CRITERION OF GODUNOV AND RYABENKII FOR DIFFERENCE SCHEMES. Robert D. Richtmyer (New York Univ., New York. Courant Inst. of Mathematical Sciences). Aug. 24, 1964. Contract AT(30-1)-1480. 33p. Dep.(mn); $3.00(cy), 1(mn) OTS.

The report is based on a lecture given in July 1964, in a special series of lectures on the numerical treatment of boundary conditions in finite-difference calculations. The stability criterion introduced by Godunov and Ryabenkii as a guide to the effect of boundary calculations on stability is described together with an application made by D. A. Quarles, Jr. to shock fitting in fluid dynamics. The criterion is in the spirit of the von Neumann condition in that it is concerned with local normal modes of the linearized difference equations; it is formalized in terms of the concept, defined by Godunov and Ryabenkii, of the spectrum of an infinite family of linear operators, and the main theorem of the theory, reproduced in a simplified form here, shows how to test this criterion, in the case of one space variable, by the study of the local normal modes near the boundary, as well as in the interior. (auth)

875 (UCRL-11222) FORTRAN PROGRAM SUMX. Lynn Champomier (California. Univ., Berkeley. Lawrence Radiation Lab.). Apr. 15, 1964. Contract W-7405-eng-48. 74p. Dep.; $3.00(cy), 2(mn) OTS.

SUMX is a data-summarizing program written in FORTRAN II for IBM 709/7090. SUMX constructs displays in the form of lists, histograms, graphs, etc., from information extracted from sets of records on an input tape. Control cards specify the sets of records, the information to be extracted from each set, and finally, what sort of display is to be made from the information. (auth)

876 (UCRL-11363) POCKET—A POOR MAN'S LIBRARY SYSTEM FOR COMPUTER. Alan Natapoff (California. Univ., Berkeley. Lawrence Radiation Lab.). Apr. 8, 1964. Contract W-7405-eng-48. 43p. Dep.; $2.00(cy), 1(mn) OTS.

A computer library system, POCKET, which was designed for general use with scientific experiments, is described. POCKET is written entirely in FORTRAN IV programming language and can be applied to a wide variety of tasks by providing an optional, user-written subroutine. The program accepts and yields a variety of input and output forms, under the direction of the user. A versatile control-card reading routine permits the entry of arbitrary additional data. POCKET is designed to be convenient, versatile, and simple at the cost of speed. On a typical problem, it handled the input and output of about 1600 records per minute on the 7094, using standard FORTRAN library routines. A simplicity of logic is achieved by imbedding the forms both of the library records and the editing instructions in the same form. The system has been in use for several years. (auth)

877 AUTOMORPHIC FUNCTIONS AND SPECTRAL THEORY (NON COMPACT CASE). K. Maurin (Univ. of Warsaw and Inst. of Mathematics, Warsaw). Bull. Acad. Polon. Sci., Ser. Sci. Math. Astron. Phys., 12: 385-90(1964).

In the theory of automorphic functions one makes usually the assumptions that G is a semisimple Lie group, K its maximal compact subgroup, and Γ is a discrete subgroup of G such that the homogeneous space G/Γ is compact. The compact case leads to completely continuous operators with discrete spectral decomposition. The general non-compact case (G/Γ not supposed to be compact) is treated. The nuclear space $D(K\backslash G/\Gamma)$ is constructed, as is a Gelfand triplet $D(K\backslash G/\Gamma) \subset H \subset D'(K\backslash G/\Gamma)$, where H is the completion of the space $D(K\backslash G/\Gamma)$ with respect to the scalar product $\int_F \varphi\bar{\psi}\, dx$. (F is a Γ-fundamental domain in $X = K\backslash G$). The Gelfand assumption (that the convolution algebra $D(K\backslash G/K)$ is commutative) allows us to apply spectral theory, and to decompose the space H into a direct integral $\int H(\lambda)\, d\mu(\lambda)$ (where elements of $H(\lambda)$ are regular automorphic functions). Theorems are proven for vector-valued automorphic functions. (auth)

878 STUDIES IN PERTURBATION THEORY. PART VI. CONTRACTION OF SECULAR EQUATIONS. Per-Olov Loewdin (Univ. of Florida, Gainesville and Uppsala Univ.). J. Mol. Spectry., 14: 112-18(Oct. 1964).

The partitioning technique for solving secular equation is discussed. It is shown that the original secular equation may be transformed to a contracted secular equation referring to the specific subspace under consideration. The technique may be applied to heteroatoms in a molecule, to central atoms in a crystal field, to chemical bonds in a molecular environment, and to discuss the question of dressed and undressed particles. If the system under consideration is not complete, the addition of a complementary subspace leads to a new term in the Hamiltonian corresponding to a dressing of the system involved. It is shown that eigenvalue problems associated with contracted Hamiltonians may be solved by iteration procedures and particularly that there exists a second-order iteration procedure that is a generalization of the conventional variation principle. (auth)

879 STUDIES IN PERTURBATION THEORY. PART VII. LOCALIZED PERTURBATION. Per-Olov Loewdin (Univ. of Florida, Gainesville and Uppsala Univ.). J. Mol. Spectry., 14: 119-30(Oct. 1964).

A perturbation is said to be localized if only a few elements of the energy matrix are influenced in a specific representation. The corresponding Schrödinger equation can be transformed to a form that focuses the interest on those energy values as are changed by the perturbation. The associated secular equation contains the energy as a nonlinear parameter, and it may be solved numerically by the second-order iteration procedure developed in a previous paper. The cases of a perturbation of a single diagonal element and a pair of nondiagonal elements are treated separately as illustrative examples. The method is applicable to hetero-atoms in molecules, to impurities in solids and to molecular structures with extra bonds, etc. (auth)

880 STUDIES IN PERTURBATION THEORY. PART VIII. SEPARATION OF DIRAC EQUATION AND STUDY OF THE SPIN-ORBIT COUPLING AND FERMI CONTACT TERMS. Per-Olov Loewdin (Univ. of Florida, Gainesville and Uppsala Univ.). J. Mol. Spectry., 14: 131-44 (Oct. 1964).

Separation of the Dirac relativistic wave equation was studied for one electron by means of the partitioning technique. This technique is a powerful tool for the evaluation of energy eigenvalues of the stationary states by means of a second-order iteration procedure, which is closely connected with the quantum mechanical variation principle. Essentially studies were made on the operator aspects of the partitioning of the Dirac equation and also the numerical aspects. A complete orthonormal basis and the matrix representation of the operators involved are introduced. For certain systems, the nonrelativistic eigenvalues and eigenfunctions are known with a fair amount of accuracy, and it seems plausible that this data would form a convenient starting point for the second-order iteration procedure connected with partitioning technique. In this way the relativistic corrections should be obtained in a rather simple way. (P.C.H.)

METALS, CERAMICS, AND OTHER MATERIALS

General

881 (AD-600363) SURVEY OF CURRENT KNOWLEDGE OF THE DEFORMATION CHARACTERISTICS OF BERYLLIUM AND THE REFRACTORY METALS. Quarterly Progress Report No. 3, December 15, 1963–March 31, 1964. F. W. Boulger, A. R. Rosenfield, and D. E. Strohecker (Battelle Memorial Inst., Columbus, Ohio). Apr. 22, 1964. Contract N600(19)-60240. 87p. $2.25(OTS).

Effort was concentrated on preparing interpretive reports on the extrusion process, the mechanisms and effects of dynamic strain aging, and the relationships among thermomechanical treatments and the resulting properties of metals. The engineering analysis of the extrusion process is given. Articles on the other two subjects will be completed and reports will be prepared on the rolling and forging processes. (auth)

882 (AD-600403) PROCESS IMPROVEMENT OF COLUMBIUM (Cb-752) ALLOY. Phase II, Interim Engineering Progress Report, December 1, 1963–March 31, 1964. J. G. Bewley and M. Schussler (Union Carbide Corp. Stellite Div., Kokomo, Ind.). Contract AF33(657)-11210. 86p. $4.00(OTS).

Approximately 800 pounds of Nb-752 alloy ¼-inch thick sheet bar were processed to 0.060-inch thickness, 30-inches width sheets. About 200 pounds of sheet in 0.060-, 0.030-, 0.018-, and 0.012-inch gages were produced from this material and furnished in the recrystallized condition. A solution treatment at 2800°F, followed by 40% reduction by cold rolling, with a final anneal at 2400°F appears to produce the best combination of strength and ductility. This route will be used in the fabrication to the final sheet gages of 0.030-, 0.018-, 0.012-, and 0.008-inch. (auth)

883 (AD-600764) FURTHER DEVELOPMENT OF A DUCTILE TUNGSTEN-BASE SHEET ALLOY. Summary Report, February 3, 1963–April 3, 1964. J. L. Ratliff, D. J. Maykuth, H. R. Ogden, and R. I. Jaffee (Battelle Memorial Inst., Columbus, Ohio). Apr. 30, 1964. Contract N600(19)-59738. 81p. $2.25(OTS).

The alloying approach employed was to study the combined effects of small additions of rhenium or iridium to tungsten for matrix softening and fine inert oxide dispersions of ThO_2 or ZrO_2. Also, the effect of alkali-silicate doping additions to the matrix were studied as to their ability to control grain size and recrystallization behavior. Optimum property combinations were found for W–5Re–ThO_2 type alloys prepared using a commercially doped tungsten powder. The culmination of this research was the development of a W–5Re–4ThO_2 alloy which showed an ultimate strength of 193 ksi, a yield strength of 182 ksi, and a 6% elongation in tension at room temperature. This alloy showed a 1-hour recrystallization temperature of 2000°C and an ultimate tensile strength of 36.6 ksi at 1650°C. (auth)

884 (AERE-R-3909) THE EFFECT OF PRESSURE ON THE RESISTANCE OF A GRAPHITE JOINT. R. J. Moulton (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). June 1964. 17p. Dep.; $0.60 (BIS), 3s.(HMSO).

Experiments have been carried out to determine the effect of pressure on the resistance of a graphite/graphite joint to both heat and electrical flow. Hysteresis effects of joint resistance with pressure and some effects of surface finish were also noted. (auth)

885 (BMI-1692) PHASE, THERMODYNAMIC, OXIDATION, AND CORROSION STUDIES OF THE SYSTEMS URANIUM–NITROGEN. Joseph Bugl and Arthur A. Bauer (Battelle Memorial Inst., Columbus, Ohio). Sept. 4, 1964. Work Performed under United States–Euratom Joint Research and Development Program. Contract W-7405-eng-92. 40p. (EURAEC-1210) Dep.(mn); $2.00(cy), 1(mn) OTS.

The pressure-temperature dependence of UN decomposition and melting, of equilibrium between the UN and U_2N_3 phases, and of nitrogen solution in the U_2N_3 phase was determined as well as the solubility of UN in liquid uranium. From the experimental data, thermodynamic functions for the formation of U_2N_3 from UN and nitrogen gas and for the solution of nitrogen in U_2N_3 were determined. For the latter, integrated thermodynamic functions for the solution of nitrogen in U_2N_3 were calculated. The oxidation kinetics of UN in CO_2, oxygen, and water-saturated air were found to obey the linear weight-gain law with activation energies ranging from 10,400 to 15,400 cal per mole. The oxidation product in atmospheric gas at temperatures of 300°C and greater was U_3O_8. UN corroded in 300°C water to form UO_2, but the rate of corrosion was highly sensitive to stoichiometry and to density with cast, 100 per cent dense, stoichiometric UN exhibiting optimum corrosion resistance as compared with nonstoichiometric UN prepared either by casting or by powder metallurgy. Corrosion rates in 100°C water, 350°C Santowax R, and 820°C NaK were low or negligible. (auth)

886 (CEA-R-2535) FABRICATION ET PROPRIETES DE CORPS CARBONES PREPARES PAR CRAQUAGE DE GAZ NATUREL. (Preparation and Properties of Carbonaceous Products Prepared by the Cracking of Natural Gas). P. Blum, L. Bochirol, J. Rappeneau, P. Cornuault, R. Blanchard, C. Moreau, and J. Philippot (France. Commissariat a l'Energie Atomique. Centre d'Etudes Nucleaires, Grenoble). 1964. 41p. Dep.(mn).

Complete results are presented of tests recently carried out in an attempt to transform natural gas (gas from Lacq), used as a source of pyrolytic carbon, into carbonaceous products with improved properties. Several methods have been studied: (1) By using normal grade industrial graphite as support (density of about 1.50) products having densities of about 1.80 are obtained. Their open porosity (6 to 7 per cent) is lower than that of conventional graphites, and several of their characteristics are more or less equal to, or better than those obtained from a double impregnation witch pitch. (2) The use as supporting material of the semi-products ("cooked") usually used for graphite production does not lead to satisfactory results. The main reasons for this are given. (3) A new process, called "BB5", has been developed. The starting materials here are powdered products (petrol coke or graphite) which are put into shape with the use of a binder which can be dispersed in water. The supports thus produced make it possible, because of their porous structure, to make the most of the densification produced by cracking natural gas below 1000°C. The products obtained, which are made up of equal amounts approximately of the supporting material and of pyrocarbon can attain densities of over 1.90. Their very low open porosity can be reduced almost to zero and their impermeability is then excellent ($k = 10^{-8}$ cm^2sec^{-1}). They have also a remarkably high resistance to compression, values of 15 to 20 kg/mm^2 being obtained for those carbons which have not undergone a final graphitization treatment. Some examples are given of possible nuclear applications of the materials produced in this manner. (auth)

887 (DP-860(Vol.I)) STAINLESS STEEL INFORMATION MANUAL FOR THE SAVANNAH RIVER PLANT. VOL. I. PROPERTIES. W. C. Rion, Jr., comp. (Du Pont de Nemours (E. I.) & Co., Wilmington, Del.). July 1964. Contract AT(07-2)-1. 211p. Dep.; $6.00(cy), 4(mn) OTS.

The manual provides information on the physical, me-

chanical, corrosion, radiation, and structural properties of stainless steels. The data are for use in the design and fabrication of stainless steel equipment or in making process changes that may affect the performance of the equipment. It is pointed out that the stainless steels are extremely vulnerable to several forms of corrosion. (D.L.C.)

888 (DP-904) PAPERS PRESENTED AT THE X-RAY PREFERRED ORIENTATION MEETING AT SAVANNAH RIVER LABORATORY, JUNE 7, 8, 1962. Edward F. Sturcken, ed. (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). July 1964. Contract AT(07-2)-1. 129p. Dep.; $4.00(cy), 3(mn) OTS.

A meeting was held by representatives of the USAEC feed materials, national laboratories, and production reactor sites to discuss techniques for measurement of grain orientation in uranium and the development of methods for predicting the irradiation growth that occurs in uranium fuel elements because of preferred grain orientation. The papers on x-ray diffraction techniques described intersite exchange of standards, x-ray diffraction from highly radioactive materials, techniques for measuring texture gradients, and the measurement of grain size from statistical fluctuation in x-ray diffraction intensity. Papers on preferred orientation measurements included the effects of various heat treatments and fabrication procedures on the texture, texture gradients, and grain size of uranium fuel elements of various geometrical shapes. Papers concerning the development of theories for predicting irradiation growth included the strain tensor theory for irradiation growth (growth index method), the form of a theory that would include the interaction between grains during growth, deformation modes of uranium single crystals, and crystal structure variations in uranium at low temperature. Separate abstracts were prepared for 12 of the 14 papers. For the other two papers, see NSA 17: 10894 and 37460. (D.L.C.)

For abstracts of individual papers see: 721, 889, 890, 891, 946, 947, 948, 949, 950, 951, 979, and 993.

889 (DP-904(p.35-51)) TECHNIQUES FOR MEASURING TEXTURE GRADIENTS IN TUBULAR URANIUM FUEL ELEMENTS. B. G. LeFevre and E. F. Sturcken (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.).

The fact that preferred orientation changes with depth in the wall of a fuel element necessitates measurements at a number of depths in the wall. Sampling techniques were developed for measuring preferred orientation gradients in thick-walled tubular elements by x-ray diffraction. Texture coefficients and growth indices were determined for beta-heat-treated, oil-quenched uranium fuel elements. Inverse pole figures were used to show the types of preferred orientation at the center and outer surfaces. (D.L.C.)

890 (DP-904(p.52-9)) PREPARATION OF SPECIMENS FOR TEXTURE GRADIENT MEASUREMENTS. (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.).

Techniques are given for the machining and mounting of samples from uranium tubes for x-ray scanning. Radial, tangential, and longitudinal samples are covered. (D.L.C.)

891 (DP-904(p.75-81)) TEXTURE GRADIENTS IN OIL-QUENCHED, MARK-VB OUTER FUEL CORES. V. Morton, R. N. Thudium, N. Crank, Jr., and C. A. Powell (National Lead Co. of Ohio, Cincinnati).

This paper appeared in NLCO-850.

Three Mark V-B outer fuel cores were examined for texture gradients in the longitudinal, tangential, and radial directions as functions of radial position. Two of these cores were beta-treated and oil-quenched with excess stock on the ID and OD. Sampling techniques are described; the G_2, G_3, and J data are tabulated; and plots of longitudinal, tangential, and radial G_3, as functions of radial position, are presented. (auth)

892 (DP-927) TENSOR PROPERTIES OF ORIENTED METALS. Edward F. Sturcken and Jesse W. Croach (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Oct. 1964. Contract AT(07-2)-1. 16p. Dep.; $1.00(cy), 1(mn) OTS.

The theory for predicting anisotropic physical properties that result from preferred grain orientation was generalized, in analogy to the theory of linear homogeneous strain, to permit prediction of physical properties in all directions of the material from preferred orientation measurements in six or more directions. The theory is applicable to those properties that can be described to a first approximation by a second-order tensor, such as electric resistivity, thermal coefficient of linear expansion, heat conductivity, thermal emf, magnetic susceptibility, and irradiation growth. (auth)

893 (EURAEC-1216) THE RELATIONSHIP OF NITROGEN CONTENT OF AUSTENITIC STAINLESS STEELS TO STRESS CORROSION. Quarterly Report No. 1, June 1–September 30, 1964. Report No. 438-1. Brownell N. Ferry (Virginia Polytechnic Inst., Blacksburg). Sept. 30, 1964. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(40-1)-3208. 13p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Upgrading of equipment for studying the mechanism by which nitrogen affects the susceptibility of austenitic stainless steels to stress corrosion is reported. Emphasis is placed on: design and construction of a new nitriding facility, design and construction of a chromium and nickel plating apparatus, formulating procedures for plating nickel and chromium on iron wires, and refinement of the torsional pendulum to facilitate operation. (N.W.R.)

894 (GEMP-39A) HIGH-TEMPERATURE MATERIALS PROGRAM PROGRESS REPORT NO. 39, PART A. (General Electric Co. Advanced Technology Services, Cincinnati). Sept. 30, 1964. Contract AT(40-1)-2847. 38p. Dep.; $2.00(cy), 1(mn) OTS.

Stress-rupture and creep testing of Ta–10W, Re, W–25Re and W–Re–Mo alloys at 1600°C was continued. Development work on W–Re–Mo alloys continued. Improvements in the room temperature ductility were realized after exposure at 600 to 2600°C. Efforts to fabricate a containment capsule for the POODLE program were continued. Tungsten creep-rupture specimens irradiated to a fast neutron dose of 1.6×10^{19} nvt and tested at 900°C indicated: the time-to-rupture increased by a factor of 2.5 for a specimen annealed at 1200°C for 1 hour prior to testing at 900°C when compared to a similar as-irradiated specimen, and the as-irradiated and the irradiated plus 1200°C annealed specimens resulted in time-to-rupture increases by factors of approximately 5 and 10, respectively, when compared to the unirradiated control specimen. Annealing tungsten creep-rupture specimens at temperatures above 1300°C resulted in times-to-rupture less than the as-irradiated specimen, but still factors of 2 to 3 longer than that observed for the control. Tungsten creep-rupture specimens irradiated to 8×10^{19} nvt and annealed at 1200°C for 1 hour prior to testing at 900°C resulted in estimated times-to-rupture greater by a factor of 20 than those for a corresponding control specimen. Tungsten specimens irradiated to 1.3×10^{20} nvt and tested at 1100°C indicated that there was an apparent recovery of radiation-induced strengthening at the low stresses. The time-to-rupture was increased by a factor of 12.5 when tested at a stress of 18.25 kg/mm^2 and a temperature of 1100°C. Specimens irradiated to 8×10^{19} nvt showed an increase by a factor of about 6 in the time-to-rupture. Creep-rupture testing of Hastelloy X specimens at 732°C indicated that the radiation-induced changes were not as great as those at 650°C. Annealing resulted in almost complete recovery of the radiation-induced reduction in rupture life and ductility. Creep-rupture testing at 732°C of A-286 specimens irradiated in the shielded-unshielded capsule indicated that the changes for shielded specimens were greater than corresponding specimens tested at 650°C when compared to

the control data. The difference between the time-to-rupture for the shielded and the unshielded specimens when tested at 732°C was not as great as that observed for similar specimens tested at 650°C. The rupture life for shielded specimens tested at 650°C approached those of the unshielded specimens at the higher test temperatures. Annealing an unshielded specimen for 9 hours at 732°C did not significantly affect irradiation-induced changes. Therefore, the effect of thermal neutron flux appears to be significantly greater for the precipitation-hardening alloy (A-286) than for the solution-strengthened alloy (Hastelloy X). The effect of 3- and 6-month nuclear transmutations at 10^{14} thermal neutron flux on the thermoelectric output in the W/W–25Re thermocouple system was identified by synthesizing a series of alloys representing the transmutation products. The electrical resistance of Y_2O_3 was determined as a function of temperature up to 2500°K. High-temperature metal-ceramic seals of niobium to Lucalox were given thermal treatments up to 1950°C for 6.5 hours without any degradation in microstructure. (auth)

895 (HW-82400) PROCEEDINGS, COMMERCIAL FABRICATION OF PLUTONIUM FUELS, HANFORD LABORATORIES INVITATIONAL MEETING, RICHLAND, WASHINGTON—APRIL 2-3, 1964. J. G. Bradley, comp. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). July 1964. Contract AT(45-1)-1350. 147p. Dep.; $4.00(cy), 3(mn) OTS.

Eight papers were presented on developed plutonium fuels fabrication technology. Procurement, reprocessing, physics, radiological control, plutonium-fueled reactor operating experience, fuels irradiation experience, and economics were the topics treated. Separate abstracts were prepared for six of the papers; for the other two papers, see NSA 18: 23824 and 40759. (D.L.C.)

For abstracts of individual papers see: 530, 896, 936, 995, 1838, and 1854.

896 (HW-82400(p.2.1-13)) PROCUREMENT AND EVALUATION OF FUEL ELEMENT MATERIALS. R. E. Olson (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

A discussion is given of the procurement of Zircaloy-2 cladding and hardware and UO_2 and PuO_2 fuel materials with reference to quality, costs, and delivery schedules. The defects encountered in Zircaloy-2 tubing are described together with testing methods. (D.L.C.)

897 (HW-83386) N-REACTOR PROCESS TUBE ROLLED JOINT. J. H. Fastabend (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Aug. 1964. Contract AT(45-1)-1350. 45p. Dep.; $2.00 (cy), 1(mn) OTS.

The rolled joint met or surpassed all design and operating criteria under which it was evaluated. Bending loads concurrent with thermal cycling, thermal transient tests, and burst tests were applied without separation of the joint. No leakage was detected on any of the properly formed joints tested under design conditions of 1800 psi and 600°F. Tensile strength of the joint was determined to be 50% greater than design requirements. Relaxation tendencies of the joint were evaluated over a 6 mo thermal cycling period which showed a reduction in residual interface stress of approximately 1000 psi. Studies of the effect of process water and decontamination solutions on the joint resulted in no corrosion problem. The front rolled joint did not inhibit fuel element passage. Various step heights caused no damage to fuel element feet under normal charging conditions, and only minor but acceptable damage under charging conditions over double the normal charging column load. Further testing of the rolled joint is continuing through the N-Reactor startup. Operability of the joint on a long-term basis will be observed and residual stress will be evaluated further. (auth)

898 (HW-SA-3738) PREPARATION FOR STUDIES OF THE HARDENING EFFECT OF ELECTROHYDRAULIC SHOCK WAVES TO PLUTONIUM. John H. Rector (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Oct. 5, 1964. Contract AT(45-1)-1350. 7p. Dep.(mn); $1.00(cy), 1(mn) OTS.

A research program was initiated on the possible hardening effect in the electrohydraulic forming of Pu metal. Results of a preliminary experiment on 1100-0 aluminum are reported. The experimental setup for the tests on Pu is described briefly. (D.L.C.)

899 (LA-DC-6468) MECHANISM OF ADHERENCE OF TUNGSTEN TO BODIES CONTAINING YTTRIA. Robert E. Cowan, Claude C. Herrick, and Stephen D. Stoddard (Los Alamos Scientific Lab., N. Mex.). [1964]. Contract W-7405-eng-36. 11p. (CONF-716-3) Dep.(mn); $1.00(cy), 1(mn) OTS.

From American Ceramic Society, Philadelphia, Sept. 1964.

The effects of Y_2O_3 content and metallizing temperature on the tensile strength of Al_2O_3–W bonds are described. Studies were made of the reaction between W and Y_2O_3 in wet H_2 atmospheres. It is concluded that the reactions occurring during metallizing of a Y_2O_3-bearing body with W are: (1) During the initial firing stage, W metal is partially oxidized, and some oxide is retained at temperatures as high as 800°C. (2) The W oxide reacts with Y_2O_3 or Y garnet in the grain boundaries of the Al_2O_3–Y_2O_3 ceramic. (3) When the firing temperature is raised, those Y tungstates which are unstable in H_2 are reduced to Y_2O_3 and W, resulting in migration of Y into the W. (4) A final firing temperature of ~1700°C densifies the W and causes the mixture of W, Y tungstate, and Y_2O_3 to coalesce into a hard dense structure. (D.L.C.)

900 (ML-TDR-64-125(Vol.II)) IMPROVED GRAPHITE MATERIALS FOR HIGH-TEMPERATURE AEROSPACE USE. VOLUME II. DEVELOPMENT OF GRAPHITE REFRACTORY COMPOSITES. (Union Carbide Corp. Carbon Products Div. Advanced Materials Lab., Lawrenceburg, Tenn. and Union Carbide Corp. Carbon Products Div. Research Lab., Parma, Ohio). Aug. 1964. Contract AF33(657)-11171. 143p. OTS.

New graphite-base refractory composites were developed through the selective substitution of the components in grade JTA. Studies were conducted on the following composite changes: zirconium, silicon, and niobium replacement of boron; and niobium, cerium, and lanthanum replacement of silicon. Studies of graphite-oxide reactions have provided information concerning the stability of oxide coatings in contact with carbon bodies. Insight was gained into the mechanisms of such reactions when their limits of stability are exceeded. A high-temperature apparatus was developed to supplement existing oxidation tests. Cyclic tests of short duration were completed on grade ATJ, SiC-coated RVC, and grade JTA. Additional tests using exposures of 5, 15, 30, and 60 minutes over the temperature range of 1400 to 1800°C were performed on grade JTA. These data were used as a basis for screening new composites. The most oxidation-resistant composite was JT-0981 in which the boron was completely replaced with silicon. This material exhibited excellent performance at 1700, 1800, 1900, and 2000°C; however, at lower temperatures, no protective coating was formed and the performance was poor. Plasma tests conducted at 1900°C on the front face of JTA samples show its excellent oxidation resistance. Similar tests on JT-0981 were stopped when the low temperature areas on the samples were losing material faster than the hot face. (auth)

901 (MSAR-64-102) EFFECT OF HIGH-TEMPERATURE SODIUM ON AUSTENITIC AND FERRITIC STEELS. PHYSICAL PROPERTIES OF MATERIALS. Progress Report No. 48, August 1964. (MSA Research Corp., Callery, Penna.). Sept. 14, 1964. Contract AT(11-1)-765. 28p. Dep.(mn); $2.00(cy), 1(mn) OTS.

The creep, creep-rupture, and fatigue properties of type 316 stainless steel in air, helium, and carbon-saturated and oxygen-saturated sodium at 1200°F are being evaluated. The carburization of Armco Iron, type 316 and 304 stainless steel, and chromium-molybdenum steel in sodium at

1200°F is studied by evaluating exposure time, carbon content, surface penetration, and hardness. (N.W.R.)

902 (RFP-428) DEUTERIDED LITHIUM WIRE. J. L. Guyton and K. Terada (Dow Chemical Co. Rocky Flats Div., Golden, Colo.). Oct. 7, 1964. Contract AT(29-1)-1106. 9p. Dep.; $1.00(cy), 1(mn) OTS.

Lithium deuteride-coated lithium wire was successfully fabricated by extruding lithium wire and reacting it with deuterium at temperatures between 80°C and 450°C. By controlling the reaction time and temperature, it is possible to produce a wire with a predetermined coating thickness. Because the resulting coated wire is extremely brittle, making it difficult to handle and subject to oxidation, handling in an inert atmosphere is desirable. (auth)

903 (SRIA-128) SORPTION OF GASES ON METAL SURFACES IN ULTRAHIGH VACUUM. Quarterly Progress Report No. 8, May 15–August 15, 1964. B. Bergsnov-Hansen, A. P. Brady, N. Endow, and R. A. Pasternak (Stanford Research Inst., Menlo Park, Calif.). Aug. 31, 1964. Contract AT(04-3)-425. 17p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The interactions of hydrogen and deuterium with the walls of the system were studied by the quadrupole mass spectrometer. Some data for the deuterium–hydrogen exchange reaction on a molybdenum filament were obtained, and a mechanism for the reaction was formulated. The study of evaporated films was hampered by accidents. The magnetic deflection type mass spectrometer was finally made to work satisfactorily. (N.W.R.)

904 (SWRI-1228-31) STUDY OF METHODS OF INITIATING A CRACK IN THE PM2A VESSEL. Special Report. C. E. Lautzenheiser (Southwest Research Inst., San Antonio). Aug. 19, 1964. Contract AT(11-1)-1228. 27p. Dep.(mn); $2.00(cy), 1(mn) OTS.

A brief study was made of three methods for initiating cracks in A302 Grade B steel: (1) impact loading of chisel, (2) notching and fatigue cycling, and (3) placement of brittle weld crack starter bead on specimen, notching of bead, and fatigue cycling. It is concluded that the weld-fatigue cycling method is best. (D.L.C.)

905 (SWRI-1228-37) STUDIES OF THE FATIGUE STRENGTH OF PRESSURE VESSELS. (1) CYCLIC PRESSURE TESTS OF LARGE SIZE PRESSURE VESSELS, (2) LOW CYCLE FATIGUE TESTING OF ONE-HALF SCALE MODEL PRESSURE VESSELS. (3) EFFECT OF WELD DEFECTS ON THE FATIGUE STRENGTH OF A302B STEEL. Progress Report No. 10. A. G. Pickett, W. R. Schmidt, S. C. Grigory, A. R. Whiting, and H. C. Burghard (Southwest Research Inst., San Antonio). Sept. 21, 1964. Contract AT(11-1)-1228. 43p. (SWRI-1228-38; SWRI-1228-39) Dep.(mn); $2.00(cy), 1(mn) OTS.

Progress is reported on a research program which is being conducted to develop information for the analysis or prediction of pressure vessel strength and service life. In the tests on ½-scale models, the development of failures and cracks in the SWRI model after 227,685 cycles and in the Penn State Vessel Nozzle R after 82,641 cycles is described. Ultrasonics was used to follow the crack growth in the Penn State Vessel Nozzle R, and its flexibility factors are discussed. Bending tests were run on the Penn State Vessel Nozzle D for an experimental stress analysis and the determination of flexibility factors. In the studies of weld defects in A302B steel, fatigue tests were completed on as-received plate specimens, and results are presented of a study of the topography of the fracture surfaces of a plate specimen and a welded specimen. (D.L.C.)

906 (TID-21114) HIGH-TEMPERATURE OXIDATION AND NITRIDATION OF NIOBIUM IN ULTRAHIGH VACUUM. Quarterly Report No. V, January 1–March 31, 1964. R. A. Pasternak (Stanford Research Inst., Menlo Park, Calif.). Apr. 15, 1964. Contract AT(94-3)-115.[1] 23p. Dep.(mn); $1.00(cy), 1(mn) OTS.

An experimental study of the sorption of nitrogen by a niobium ribbon was completed, and study of oxygen uptake by a niobium sample was initiated at high temperatures. (N.W.R.)

907 (TID-21221(p.155-75)) EURATOM'S ACTIVITY IN THE FIELD OF URANIUM OXIDE. P. Fernet (European Atomic Energy Community).

A review is presented of Euratom research and development on conventional fabrication of UO_2 (sintering), advanced methods of fabrication (vibratory compaction, swaging, and spray coating), physical properties, and irradiation behavior. (D.L.C.)

908 (TID-21249) I. A STUDY OF RARE GAS DIFFUSION THROUGH SOLIDS AND II. ANALYSIS OF GEOLOGIC AND COSMOLOGIC SAMPLES. Final Report. Joseph I. Lipson (Pittsburgh. Univ.). Sept. 30, 1964. Contract AT(30-1)-2951. 11p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Mass spectrometric studies of helium permeation of Kovar indicate that such permeation does occur, but the results are only qualitative owing to the fact that a vacuum gage was left on. Some observations are also reported on the anisotropy of the ionic conductivity of natural feldspar crystals. (D.L.C.)

909 (UNC-5096) STUDY OF URANIUM–PLUTONIUM MONOXIDES. Progress Report, February 1, 1964–July 31, 1964. D. Stahl, A. Strasser (United Nuclear Corp. Development Div., White Plains, N. Y.); J. Andersen, and K. Taylor (Carborundum Co., Niagara Falls, N. Y.). Oct. 5, 1964. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(30-1)-3305. 39p. (EURAEC-1222). Dep.(mn); $2.00(cy), 1(mn) OTS.

Large amounts of Pu(OC) phase mixed with Pu_2O_3 were synthesized by carbon reduction of PuO_2. Single-phase Pu_2O_3 was also formed by the same process by adjustment of the carbon content in the reaction mixture. Pellets of these materials were produced by cold pressing and sintering. A mixture of about 50% of (UPu) (OC) phase with an oxygen depleted XO_2 phase was produced by the carbon reduction of a 50% UO_2 and PuO_2 mixture. Only small amounts of (UPu)O were found mixed with two XO_2-type phases after UH_3 reduction of PuO_2. Carbon seems to be necessary for monoxide stabilization. Pellets of the monoxide and dioxide mixture were produced by cold pressing and sintering. The gravimetric technique for oxygen-to-metal ratio by oxidation and reduction was set up and tested. (N.W.R.)

910 ELECTROWINNING MOLYBDENUM AND TUNGSTEN. Don H. Baker, Jr. (Bureau of Mines, Reno, Nev.). J. Metals, 16: 873-6(Nov. 1964).

The technical feasibility of molten salt electrowinning of Mo or W from oxides or naturally occurring compounds is discussed. Electrolysis is carried out using a graphite crucible as the anode and a graphite rod as the cathode. Tungsten is electrowon from tungstic oxide and scheelite using a ternary electrolyte of sodium pyrophosphate, sodium chloride, and sodium tetraborate. Temperature effects on the quality of the product is discussed, and it is shown how the size of crystals is influenced by current density. Molybdenum is electrowon using a mixture of sodium tetraborate, sodium chloride, and calcium fluoride. Feed materials may be molybdic oxide or scheelite. Molybdenum carbide may be electrowon from molybdenite or molybdenum sulfide. The molybdenum carbide is then sintered with molybdic oxide to produce the metal. Data are tabulated. (P.C.H.)

911 HYDROGEN REDUCTION OF MOLYBDIC OXIDE. 1. BY A GAS RECYCLE SYSTEM. Herbert Kay (Climax Molybdenum Co., New York) and B. G. Langston. J. Metals, 16: 877-81(Nov. 1964).

The development of a system that utilizes a gas recycle system for control of the reactions required for the conversion of molybdic oxides to molybdenum metal is described. Hydrogen is used as the reducing gas and the pilot plant process is carried out on a continuous basis in a shaft furnace. The effect of adding make-up hydrogen to

the furnace on the conversion to the metal is discussed, along with the effect of the temperature of the recycling gas on the reduction temperature. The rate of the reduction of molybdenum trioxide to molybdenum dioxide is effected by the concentration of hydrogen and the temperature. The rate of reduction of molybdenum dioxide to molybdenum is also discussed. The gas recycle system can also be used for batch conversion of molybdenum oxides using a retort. (P.C.H.)

912 HYDROGEN REDUCTION OF MOLYBDIC OXIDE. 2. BY A FLUIDIZED-BED REACTOR. A. B. Michael (Glidden Co., Hammond, Ind.) and J. E. Hanway, Jr. J. Metals, 16: 881-4(Nov. 1964).

The commercial development of a fluidized-bed hydrogen reduction process for Mo that provides a continuous, high-capacity, and efficient method for producing metallic Mo is described. The effects of the temperature at which the reduction is carried out on the purity are discussed, along with the thermal energy for the reaction, rate of growth of particles of the product, agglomeration, and sintering of the product in the reactor. High-quality Mo metal can be consistently produced by the reduction of MoO_3 with hydrogen at 955°C in a fluidized-bed system. The weight loss of the product averaged about 0.015%. (P.C.H.)

913 REACTOR FUELS. Nucleonics, 22: No. 10, 94; 96; 98-102; 104(Oct. 1964).

A summary is given of Geneva Conference papers on the performance of metallic, ceramic, and alloy fuels. Fuel economic studies were also outlined. (C.E.S.)

914 REACTOR MATERIALS. Nucleonics, 22: No. 10, 118; 120-1(Oct. 1964).

A summary is given of Geneva Conference papers on the development of reactor materials including aluminum, aluminum alloys, and zirconium–niobium alloys. (C.E.S.)

915 ULTRASONIC ATTENUATION IN METALS IN THE FLUID-DYNAMIC APPROXIMATION. L. H. Hall (Univ. of California, Santa Barbara). Phys. Rev., 136: A1136-40(Nov. 16, 1964).

Ultrasonic attenuation in metals was discussed from diverse points of view, and for the most part the derived attenuation formulas reduce in the first-order low-frequency limit to the viscous dissipative expression originally proposed by Mason. A treatment for the low-frequency range which makes immediate contact with the transport-theory formalism of classical gases is presented. Fluid-dynamic equations for the metal are formulated. For the electron-gas component a complete set of transport coefficients, including the several diffusion coefficients, is derived in a unified way to the simplifying assumption of a constant relaxation time. The acoustic attenuation coefficient for a longitudinal wave is deduced; the dominant term is of course the shear viscous one, but thermal and diffusion effects are also explicit. (auth)

916 THE ROLE OF ARC-PLASMA IN METALLURGY. A. R. Moss and W. J. Young (Royal Armament Research and Development Establishment, Fort Halstead, Sevenoaks, Kent, Eng.). Powder Met., 7: 261-89(1964).

Arc-plasma is introduced by a comparison with conventional heat sources. The mechanism and requirements of arc-plasma devices and equipment are then considered. An arc-plasma materials-deposition unit for automatic operation in an atmosphere of controlled composition and pressure is described. Photographs of objects plasma-spray-formed in tungsten are shown, together with microstructures of plasma-sprayed refractory deposits. Metallurgical applications of arc-plasma technology are considered under four headings: Plasma as a user: the requirements of powders for arc-plasma purposes are discussed. Plasma as a producer: extractive metallurgy, production of ultrafine—and spherical—particles, powders of intermetallic compounds and alloys. Plasma as a fabricator: consideration of spraying, spray-welding, spray-forming, cutting, and arc-plasma furnaces, including King's rotating-plasma furnace. Plasma as a tester: plasma for the analyst, application to thermal endurance, ablation, and thermal-shock testing. (auth)

917 COMPOSITE MATERIALS OF BORON CARBIDE AND COPPER AS NEUTRON ABSORBERS FOR SHUTDOWN RODS. O. Ruediger, G. Lohrke, and J. Willbrand (Versuchsanstalt der Fried. Krupp WIDIA-Fabrik, Essen). Tech. Mitt. Krupp. Forschungsber., 22: 41-7(Aug. 1964). (In German)

Composite materials of boron carbide and copper as tubular neutron absorbers for shutdown rods are manufactured with a circular cutting machine. Thermal conductivity amounts to 0.003 cal/cm/s/deg. Diffusion behavior of copper/Nimonic 75 and copper/V2A stainless steel at 900°C is studied. Copper/Nimonic 75 forms a wide, copper/V2A stainless steel a narrow diffusion zone, the wide zone having precipitations of $M_{23}C_6$. (auth)

918 PURIFICATION OF TECHNICAL METALLIC RHENIUM AND ITS PREPARATIONS. V. A. Obolonchik. Zh. Prikl. Khim., 37: 2046-7(Sept. 1964). (In Russian)

Preparation of 99.99% pure Re from powdered technical rhenium dissolved in nitric acid is described. (R.V.J.)

919 EXTRACTION AND METALLURGY OF URANIUM, THORIUM AND BERYLLIUM. R. G. Bellamy and N. A. Hill. A Pergamon Press Book. International Series of Monographs on Nuclear Energy. Division VIII. Materials. Volume 1. New York, The Macmillan Company, 1963. 206p.

Information is included on: the history, occurrence, and uses of the three metals; extraction from their ores; fabrication; properties; alloy studies; and toxic hazards and safety precautions. (P.C.H.)

Corrosion

920 (BMI-X-312) CATHODIC PROTECTION OF THE HYDROFLUORINATOR. P. D. Miller, L. K. Matson, and E. F. Stephan (Battelle Memorial Inst., Columbus, Ohio). Sept. 25, 1964. Contract W-7405-eng-92. 14p. Dep.(mn); $1.00(cy), 1(mn) OTS.

It was demonstrated that cathodic protection would reduce corrosion of submerged INOR-8 components in fused salt systems. On the other hand, negligible protection was provided at the interface areas at practical current densities (less than 10 amp/ft^2). In view of this, the technique appears to have severely limited application. The results also indicate that some cathodic protection would be provided to the container if it is in contact with the Zircaloy fuel element during dissolution, since the Zircaloy is so strongly negative with respect to INOR-8 or Hastelloy B. (auth)

921 (DP-907) STRESS CORROSION CRACKING OF TYPE 304 STAINLESS STEEL. Status Report, March 1, 1964. McIntyre R. Louthan, Jr. (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Aug. 1964. Contract AT(07-2)-1. 24p. Dep.; $1.00(cy), 1(mn) OTS.

Stress corrosion cracking of type 304 stainless steel exposed in dilute chloride solutions is being investigated in attempts to develop a fundamental understanding of the phenomenon. A description is given of the status of the stress corrosion studies that relate microstructure and dislocation substructure to transgranular stress corrosion cracking. Observations are reported which show that transgranular stress corrosion cracking, particularly during initial stages, occurs preferentially on the {111} family of planes and that such cracking most probably occurs by preferential chemical attack at lattice defects. (auth)

922 (HW-69876) ALUMINUM FOR HIGH-TEMPERATURE WATER-COOLED REACTOR SERVICE: CORROSION CONSIDERATIONS. R. L. Dillon (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). June 7, 1961. Contract AT(45-1)-1350. 12p. Dep.(mn); $1.00(cy), 1(mn) OTS.

A review is presented of the corrosion of Al and its alloys in high-temperature steam and water. The concept of corrosion regulation by dissolution of corrosion products is discussed and applied to pressurized-water and boiling-water reactors, and predictions of Al corrosion are compared with in-reactor experience. The development of Al alloys and powder metallurgy products with decreased corrosion properties is discussed. In-reactor demonstration of Al corrosion behavior and the economic incentives for Al development are discussed. (D.L.C.)

923 (HW-81746(p.3.37-40)) CONCENTRATIONS OF RADIONUCLIDES IN REACTOR FILM. C. W. Thomas and W. B. Silker (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Samples of film from downstream dummy fuel pieces were collected, separated into the outer surface layer containing the hydrous iron oxide and the subsurface aluminum oxide layer, and analyzed for the radioisotopes common to reactor effluent water. It was determined that the hydrous iron oxide coating was codeposited within the aluminum oxide matrix and still retained colloidal characteristics. The sorbed cationic radionuclides were loosely held to the film and favored the iron oxide rich layer; conversely, anionic radionuclides were tightly bound and distributed throughout the film. (auth)

924 (HW-81746(p.3.40-2)) REDUCTION OF RADIONUCLIDES IN REACTOR EFFLUENT WATER: FINAL REPORT ON THE EFFECT OF CHEMICAL ADDITIVES AND COATING MATERIALS ON THE ADSORPTION OF RADIONUCLIDE PARENT ELEMENTS IN PROCESS WATER ON ALUMINUM SURFACES. D. E. Robertson and R. W. Perkins (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

The adsorption inhibiting effect of many types of corrosion inhibitors, standard surface pretreatment processes, and coatings were evaluated both in the laboratory and in in-reactor tests. The laboratory studies revealed a number of potential process water additives and coatings as adsorption inhibitors. Reactor tests showed the coatings to be satisfactory in regions downstream from the neutron flux, but they were decomposed and unsatisfactory in the neutron flux region. (auth)

925 (HW-81746(p.3.44-9)) THE ESTIMATION OF ALUMINUM CORROSION FROM REACTOR COOLANT ACTIVITY CONCENTRATION. C. W. Thomas and W. B. Silker (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Studies were conducted to determine the use of effluent concentrations of ^{72}Ga, ^{65}Ni, and ^{24}Na as indices of the corrosion rate of aluminum reactor components. It was determined that ^{72}Ga provides a direct measure of tube and fuel jacket corrosion, and ^{65}Ni was directly correlated with fuel jacket corrosion. ^{24}Na values indicated a much higher corrosion rate than did occur. It was hypothesized that the effluent concentration of ^{24}Na provides a measure of the thickness of the aluminum corrosion product film. (auth)

926 (HW-81746(p.3.49-50)) THE EFFECTS OF HIGH ALUM AND LOW pH ON THE CORROSION OF ALUMINUM REACTOR SURFACES. C. W. Thomas and W. B. Silker (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

The corrosive effects from either varying the alum feed in the process water treatment plant or the pH of the reactor cooling water were studied under separate half-reactor tests. Alum feeds varying from 6 to 18 ppm did not noticeably affect the aluminum corrosion but varying the coolant pH from 6.6 to 7.0 significantly increased the corrosion and was most pronounced on the fuel jacket cladding. (auth)

927 (KAPL-3060) CORROSION RESISTANCE OF CONSOLIDATED ZIRCALOY-2 POWDER CONTAINING OXYGEN AND NITROGEN. A. E. Bibb, A. P. Beard, and J. F. Fascia (Knolls Atomic Power Lab., Schenectady, N. Y.). June 1964. Contract W-31-109-eng-52. 22p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Oxygen (>2700 ppm) and nitrogen (>100 ppm) additions reduced the time to transition in 680°F water and had a deleterious effect on both the 680°F water and 750°F steam corrosion resistance of consolidated Zircaloy-2 powder. Linear relationships for hydrogen weight gains were a function of oxygen weight gains irrespective of whether the data were obtained pre- or post-transition. The data suggest that the hydrogen uptake characteristics are an inherent property of the alloy and depend only on the magnitude of corrosion. Nitrogen reduced the tendency for the Zircaloy-2 to pick up the hydrogen generated in the aqueous corrosion reaction. (auth)

928 (MSAR-64-112) EFFECT OF HIGH-TEMPERATURE SODIUM ON AUSTENITIC AND FERRITIC STEELS. Progress Report No. 49, September 1964. (MSA Research Corp., Callery, Penna.). Oct. 12, 1964. Contract AT(11-1)-765. 20p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The creep, creep-rupture, and fatigue properties of type 316 stainless steel are evaluated in air, helium, and sodium containing high contents of carbon and oxygen at 1200°F. The results show a slight increase in the rupture strengths but a reduction in the ductility. The metallographic and carbon analyses are not complete, but the indications are that the chromium–molybdenum steel is decarburizing and the 304 and 316 stainless steels are carburizing. Initial impact tests are showing the chromium–molybdenum steel specimens becoming more impact resistant with increase in exposure times, while conversely the 316 stainless steel specimens become less impact resistant with increase in exposure times. (N.W.R.)

929 (NP-14434) BIBLIOGRAPHY ON LIQUID METALS TECHNOLOGY OF Hg, K, Na, AND NaK. Report No. 2550. P. L. Studt, I. M. Rehn, and J. T. Jouthas, comps. (Aerojet-General Corp., Azusa, Calif.). Sept. 1963. Contract NAS-5-417. 513p.

A large bibliography is presented of liquid metals corrosion information which may be of value to the several SNAP systems development programs. The abstracts are arranged into sections dealing with SNAP-8 materials, containment materials for liquid metal systems, design and fabrication effects on corrosion, loops, testing, etc. Several indexes are provided. (D.L.C.)

930 (ORNL-3679(p.84-7)) ELECTROCHEMICAL KINETICS AND ITS APPLICATION TO CORROSION. (Oak Ridge National Lab., Tenn.).

The kinetics of the exchange of various anions for $^{51}Cr(VI)$ in the film on passive Fe, Cr, and stainless steel was studied. The exchange process was found to be complex in all cases investigated. Iron dissolution in noninhibiting media was interpreted in terms of a mechanism which takes formal account of the simultaneous adsorption of water molecules, hydroxyl ions, and a reaction intermediate, and which provides a basis for the interpretation of the effects of adsorbed inhibitors on iron dissolution kinetics. The anodic dissolution of crystal-bar Zr in aqueous solutions containing HF and H_2SO_4 or HNO_3 was investigated with a rotating-disk electrode system. Reaction orders and rate constants were evaluated by measuring the current at constant potential as a function of concentration and rotational velocity of the disk. On the assumption that the reaction mechanism involves adsorption of HF and $SO_4^{=}$, a kinetic equation was derived which describes the results. (auth)

931 (TID-21221(p.87-109)) CORROSION AND OXIDATION STUDIES CARRIED OUT UNDER THE UNITED STATES/EURATOM AGREEMENT. Ph. Berge (European Atomic Energy Community).

A review is presented of the basic studies carried out on the oxidation and corrosion mechanisms in various metals and alloys and on radiation effects on the corrosion. The development of corrosion-resistant Zr and Nb alloys and stainless steels is also reviewed. (D.L.C.)

932 OXIDATION OF URANIUM–ALUMINUM INTERMETALLIC COMPOUNDS. II. NATURE AND SURFACE TOPOGRAPHY OF OXIDE FILMS. P. R. Openshaw and L. L. Shreir (Battersea Coll. of Tech., London). Corrosion Sci., 4: 335-44(Sept. 1964).

Oxide films formed on UAl_3, UAl_2, and UAl_4 in the range of 250–600°C were identified by x-ray diffraction and it would appear that U_3O_8 is the only oxide formed. Al_2O_3 was not detected but its presence as a thin film at the U_3O_8/UAl_x interface cannot be precluded. Electron microscopy has shown that oxide films on UAl_2 and UAl_3 are almost featureless; films on UAl_4 show concentric or random cracking depending on whether the temperature is above or below 550°C. The results were interpreted on the basis of discontinuities in the oxide film, and the fact that UAl_4 oxidizes less rapidly at 600 than at 500°C is explained by postulating that sintering of the oxide occurs at the higher temperature. (auth)

933 THE MECHANISM OF OXIDATION OF ZIRCONIUM IN THE TEMPERATURE RANGE 400°-850°C. R. J. Hussey and W. M. Smeltzer (McMaster Univ., Hamilton, Ont.). J. Electrochem. Soc., 111: 1221-4(Nov. 1964).

A study of the oxidation mechanism for zirconium in the temperature range 400–850°C, based on examination of the oxide scale growth and oxygen gradients in the metal substrate, is reported. The oxidation kinetics at long times obeyed a parabolic rate equation that was best described in terms of a diffusion model for oxygen diffusion in both the oxide and metal. From the determination of the oxygen gradients, the diffusion constant was evaluated for oxygen diffusion in alpha–zirconium. (auth)

934 KINETICS OF RECOMBINATION OF FRENKEL DEFECTS IN ANODIC OXIDE FILMS ON TANTALUM. L. Young (Univ. of British Columbia, Vancouver). J. Electrochem. Soc., 111: 1289-92(Nov. 1964).

The changes with time in the ionic conductivity of anodic oxide films on tantalum were investigated. The results are discussed in relation to the theory that Frenkel defects are present in the films and that they recombine due to the electrostatic attraction between the vacant cation sites and the interstitial ions. (auth)

935 A METHOD FOR PROTECTION OF STEEL FROM CORROSION IN SOFT WATER. I. N. Putilova, K. A. Korotchenko, and L. F. Gorin. Russian Patent 162,405.

A method for the prevention of steel corrosion in soft water by the use of starch is proposed. In order to protect the steel, 0.1% corn starch preliminarily irradiated by γ rays of ^{60}Co is introduced into the water. (OTS)

Fabrication

Refer also to abstract 326.

936 (HW-82400(p.3.1-23)) PLUTONIUM FUELS DEVELOPMENT. E. A. Evans (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

A description is given of Hanford's fabrication experience with packed-particle UO_2–PuO_2 fuel in a 19-rod cluster geometry. The fabrication steps include blending of UO_2 and PuO_2, filling cladding tubes, vibration compacting, swaging, etc. Equipment and techniques used in the fabrication are described. It is concluded that commercial fabrication of particle-type UO_2–PuO_2 rod cluster fuel elements is not difficult. (D.L.C.)

937 (MLM-1193) ELECTRON BEAM WELDING OF ANNEALED TANTALUM SHEET. J. R. McDougal and R. E. Vallee (Mound Lab., Miamisburg, Ohio). Apr. 1, 1964. Contract AT(33-1)-Gen-53. 9p. Dep.; $1.00(cy), 1(mn) OTS.

Electron-beam welding techniques were developed for joining 0.080-inch, high-purity annealed tantalum sheet. Maximum joint strength with minimum heat input was desired. In preliminary studies it was determined (1) that weld penetration of the tantalum could be controlled within ±0.003 inch; and (2) that tensile and yield strength were slightly higher for the weld metal for the parent material, although the elongation decreased from 40.5 to 23.5% due to recrystallization of the metal. Weld specimens were prepared with 0.020 × 0.020-inch step joints (which were easier to machine than the initially tested 0.010 × 0.010-inch step joints). The joint efficiency was 92% with only 75% penetration. Additionally, the low power requirements (1320 joules per inch) gave a maximum temperature of 300°C at the metal surface opposite the weld. (auth)

938 (MLM-1194) PRODUCTION OF BERYLLIUM-COATED PLASTIC WINDOWS. J. W. Voigt (Mound Lab., Miamisburg, Ohio). Apr. 1, 1964. Contract AT-33-1-GEN-53. 15p. Dep.; $1.00(OTS).

A method was developed for mass producing beryllium-coated plastic films to be used as x-ray sensory windows on tandem detection satellites. Formvar plastic was dissolved in chloroform and spread by an automatic applicator on a glass to produce a dry film weighing 20–50 $\mu g/cm^2$. Mounted on 3-inch square frames, the films were vacuum coated on both sides with beryllium, which was vaporized from a disposable boat-shaped tantalum electrode. The films were suspended from a rigid stand holding 21 frames; the rigid stand was more satisfactory than others tested because of low film breakage during deposition. To prevent film rupture, a slow evacuation and subsequent release of air into the vacuum chamber were required. The 8 to 14 seven-minute runs necessary for a satisfactory coating required about eight hours. Finished films were tested for optical density by comparing the intensity attenuation of a light source due to the film with attenuation by standard filters; the maximum allowable light transmission was 10^{-6}. A method was also developed for determining the weight density by the attenuation of alpha rays from a polonium-210 source. This method gave values which were an average 0.5 $\mu g/cm^2$ low for beryllium films weighing up to 60 $\mu g/cm^2$. Although the techniques developed in this program were never used for actual mass production, one experienced operator could prepare 150–175 plastic films per day. The windows, then, could be coated at a rate of 21 per day per vacuum deposition unit. (auth)

939 (NMI-4802) DEVELOPMENT AND FABRICATION OF A THIRD FUEL TUBE FOR THE CP-5 REACTOR. I. B. Roll (Nuclear Metals, Inc., Concord, Mass.). Nov. 14, 1958. Contract AT(30-1)-1565. 17p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The fabrication and subsequent evaluation of methods and products in the development of a fueled composite third tube for the CP-5 fuel element assembly consisting of three concentric tubes are discussed. Specifications for the tube included 28 grams ^{235}U in a 2S-aluminum-clad Al–17.6 wt % U alloy core. Fabrication operations included casting of a large Al–U billet, extruding, and drawing the thin-walled tubing. The tapered end shapes in the core of the final tube caused the length of full thickness core to be less than desired; recommendations for specification changes are given. (R.E.U.)

940 (Y-1468) WELDED REPAIR OF FILL AND DRAIN HOLES IN HIGH-CARBON STEEL GAS-STORAGE CYLINDERS. J. C. Thompson and F. J. Lambert (Union Carbide Corp. Nuclear Div. Y-12 Plant, Oak Ridge, Tenn.). July 13, 1964. Contract W-7405-eng-26. 42p. Dep.; $2.00(cy), 1(mn) OTS.

Stress calculations based on the ASME Code requirements for a 1500-psig working pressure indicated that 63 gas storage cylinders would be operating at or above the yield point of the base metal adjacent to their $^3/_4$-inch fill and drain holes which are located in the head knuckle radius. They would be subject to catastrophic failure since they are operating below their NDT, as shown by drop-weight tests on the base material. The cylinders were forged from steel having a nominal composition of 0.50% carbon and 1.60% manganese. Due to the composition of the

metal and the fact that the plug-type repair would be accessible from one side only, a specialized welding procedure was developed to effect a full-penetration weld. Material used in the investigation was taken from a cylinder that was made available for the test. All test weldments received complete nondestructive inspection after fabrication in addition to the standard guided-bend test recommended by the ASME Boiler and Pressure Vessel Code. Tensile, hardness traverses, metallography, drop weight, and impact tests were also utilized in the evaluation. With proper welding procedures it was demonstrated that the cylinders could be welded to withstand the pressure allowed by the ASME Code Case 1205-4. The stress-relieved sections of the cylinders containing the plug welds shifted the Charpy V-notch transition curve about 100°F lower than the normalized-only (no temper) base material. The integrity and safety of the repaired cylinder exceeds that of the existing normalized cylinder with holes, as shown by the fracture resulting from the burst test of the test cylinder. (auth)

941 ELEVATED-TEMPERATURE COMPACTION OF METALS AND CERAMICS BY GAS PRESSURES. E. S. Hodge (Battelle Memorial Inst., Columbus, Ohio). Powder Met., 7: 168-201(1964).

Techniques were developed for the isostatic compaction of metals, cermets, and ceramics with no appreciable variation in density throughout the compacted structure. The temperatures needed are much lower than those normally utilized for sintering, so that a fine-grain, tough structural material can be produced. The starting material may be loose powder, cold-pressed preforms, explosively impacted preforms, coated particles, spherical particles, or vibratory-packed powder. Toxic materials are easily handled. Since the process is quite adaptable to the preparation of complex shapes by direct compaction of powders, components can be produced from the more expensive materials, such as beryllium and tungsten, with a minimum loss of material during processing. (auth)

942 EFFECTS OF PARTICLE SIZE ON THE SINTERING KINETICS IN TUNGSTEN POWDER. N. C. Kothari (Univ. of Queensland, Brisbane, Australia). Powder Met., 7: 251-60(1964).

An experimental study was made on the effects of initial particle size on sintering kinetics in tungsten powder within the temperature range 1100–1500°C. Particle size, compacting pressure, sintering time and temperature all influence the rate of sintering. Isothermal changes in density and volume were measured. The results indicate grain-boundary diffusion as the mechanism principally responsible for material transport in the case of particle sizes $< 4\ \mu$. Surface diffusion appears to be the mechanism of material transport in compacts with particle sizes of 14-16 μ. The temperature-dependence of the rate of sintering is characterized by activation energies of 101 ± 2 and 72 ± 2 kcal/mole for fine particles ($< 4\ \mu$) and coarse particles (14-16 μ), respectively. (auth)

943 THE INFLUENCE OF PRESSURE, TEMPERATURE, AND TIME ON THE HOT PRESSING OF COMMERCIAL BERYLLIUM POWDER. J. W. Butcher and D. Beasley (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). Powder Met., 7: 313-26 (1964).

For a particular batch of Brush Super-Pure–200-mesh beryllium powder the hot-pressability (defined as the length of a standard compact of >98% theoretical density), increased: continuously with pressure over the range 0–1.25 ton/in.^{2} for compacts pressed for 1 hr at 1100°C; with temperature from 1000°C to a maximum at 1150°C when pressed for 1 hr under 1 ton/in.^{2}; and to a lesser extent with time over the range 10–120 min when pressed at 1050°C under 0.25 ton/in.^{2} and at 1100°C under 1.0 ton/in.^{2} Differences in hot-pressability between various batches of the same powder were small compared with the effects of temperature and pressure. Compaction during hot pressing occurs in two stages: first, collapse of the powder column causing bulk powder flow; followed, secondly, by sintering of particles forced into close contact. The latter is accompanied by a diminution in both the number of pores and their average size and is associated with grain growth, particularly above 1100°C; after pressing at 1200°C any remaining porosity assumes a thermally stable, spherical configuration. (auth)

944 DISCUSSION ON "CAUSES OF RESIDUAL POROSITY IN SINTERED URANIUM DIOXIDE." I. Amato and R. L. Colombo (Fiat Co., Turin). Powder Met., 7: 327-9(1964).

In steam-sintering a certain make of UO_2, a decrease in the maximum density with increased soaking time and temperature (solarization), followed by little or no recovery on further treatment was observed. Since organic additives had been used to facilitate pressing, the phenomenon was attributed to the swelling and occasional merging of bubbles containing gases generated by decomposition and of the additives. As these gases are not likely to diffuse at any appreciable rate within the UO_2 matrix, the phenomenon can occur only if the matrix exhibits some plasticity at the experimental temperature. The result was confirmed by experiments, in which a different brand of UO_2 was sintered in hydrogen both with and without organic additives. (P.C.H.)

Properties and Structure

Refer also to abstract 1206.

945 (AD-60081) MECHANICAL AND PHYSICAL PROPERTIES OF TZM MOLYBDENUM ALLOY SHEET AND OF TUNGSTEN SHEET. Quarterly Progress Report No. 6, February 1–April 30, 1964. Clifford L. Dotson (Southern Research Inst., Birmingham, Ala.). May 15, 1964. Contract N600(19)59530. 85p. $2.25(OTS).

Information covers preparation of the tungsten and TZM specimens, tensile tests on the tungsten sheet, recrystallization characteristics of three TZM materials, and bend-transition temperature of the TZM sheet in the optimum condition. (auth)

946 (DP-904(p.7-21)) COMPUTATION PROCEDURE FOR DETERMINING AREA WEIGHTS FOR X-RAY DIFFRACTION STUDIES. R. N. Thudium (National Lead Co. of Ohio, Cincinnati).

A method has been devised to determine area weights for any combination of planes of an orthogonal crystal structure. A program has been written for a General Precision LGP-30 digital computer and is operable to compute area weights for any combination of planes of uranium. Areas of spherical polygons for 18 and 20 plane sets of uranium have been tabulated. (auth)

947 (DP-904(p.61-73)) DETERMINATION OF GRAIN SIZE IN URANIUM FROM STATISTICAL FLUCTUATIONS IN X-RAY DIFFRACTION INTENSITY. E. F. Sturcken and W. E. Gettys (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.).

The modified grain size equation was tested for quench-annealed uranium. Values calculated from the equation using the x-ray statistical fluctuation method agreed well with metallographic measurements on the same sample. Hence, it is concluded that the equation is correct for application to materials where the x-ray beam penetrates less than one grain depth. The grain diameter, $\langle D^2 \rangle^{\frac{1}{2}}$, obtained from the x-ray measurements was found to depend on the solid angle, and varied from $\langle D^2 \rangle^{\frac{1}{2}} = 42$ to $\langle D^2 \rangle^{\frac{1}{2}} = 83$ microns for solid angles ranging from $\Omega = 1.25 \times 10^{-3}$ to $\Omega = 10.8 \times 10^{-3}$. The dependence of $\langle D^2 \rangle^{\frac{1}{2}}$ on Ω is primarily due to substructure within the grains and is due to a lesser extent to divergence and defocusing of the x-ray beam. (The grain size equation was derived for a perfectly parallel beam.) A metallographic grain size distribution analysis of 463 grains yielded a grain diameter of 108 microns with 68% of them in the range 53 to 142 microns. The

agreement between the x-ray and metallographic measurements is excellent considering the limited resolution of the metallograph and the defocusing and divergence errors in the x-ray measurements. In addition to its application to grain size measurements, the equation is also valuable for computing the expected variance in texture coefficients for a given number of samples and a known grain size, or for computing the number of samples required to obtained a texture coefficient with a given precision when the grain size is known. (auth)

948 (DP-904(p.83-94)) THE GRAIN STRUCTURE AND ORIENTATION OF AS-EXTRUDED URANIUM TUBES—MARK-VB PRODUCTION. M. F. Garufi, R. J. Wallionis, and L. Robins (Bridgeport Brass Co., Conn.).

The uniformity of texture values and microstructural observations for alpha-extruded uranium for Mark VB production were evaluated for this interim report. The results, consisting of preferred orientation and irradiation growth indices, grain size, and inclusion distribution data, indicate that the characteristics of the extruded metal are relatively uniform between extruded tubes and stable during the production of hundreds of tubes over periods of months. The variation in properties along the length of the tubes, from front to rear, are discussed. The distinctive inclusion distribution observed in the rear section of some extruded tubes was related to the structure from the bottom of the cast ingots employed for extrusion billets. (auth)

949 (DP-904(p.95-100)) TEXTURES IN ALPHA URANIUM WHICH HAD BEEN GAMMA EXTRUDED. J. W. Starbuck (Mallinckrodt Chemical Works. [Uranium Div., Weldon Spring, Mo.]).

X-ray diffraction measurement of orientation in alloyed dingot uranium that had been gamma-extruded revealed near random structures in the axial direction. A tendency toward slight excess of [002], [023], [022], and [021] poles parallel to the extrusion axis was observed. (auth)

950 (DP-904(p.109-15)) SLIP AND TWINNING IN ALPHA-URANIUM SINGLE CRYSTALS SUBJECTED TO COMPRESSIVE LOADING. P. R. Morris (National Lead Co. of Ohio, Cincinnati).

This paper appeared in NLCO-855.

Stereographic projections have been prepared of the fraction of an arbitrarily directed compressive stress resolved as shear stress on the (010)−[100] slip system, and on the various modes of the {130}−⟨310⟩, {~172}−⟨312⟩, and {~176}−⟨512⟩ twinning systems. In the {130} and {176} systems, the $(\bar{1}30)-[\bar{3}\bar{1}0]$ and $(\bar{1}76)-[\bar{5}\bar{1}\bar{2}]$ modes are favored. In the {172} system, a composite projection indicating regions favoring the $(\bar{1}72)-[\bar{3}\bar{1}2]$, $(\bar{1}7\bar{2})-[312]$, and $(17\bar{2})-[3\bar{1}\bar{2}]$ modes has been prepared. Estimates of critical shear stresses for {130} and {172} twinning of ~0.74 kg/mm^2 and ~0.89 kg/mm^2, respectively, have been drawn from the work of Lloyd and Chiswik. If a critical shear stress for {176} twinning exists, it must be of the order 10 kg/mm^2. (auth)

951 (DP-904(p.117-23)) PREDICTION OF THERMAL EXPANSION COEFFICIENTS BY THE GROWTH INDEX METHOD. E. F. Sturcken (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.).

Equations were derived for the thermal expansion coefficient, α_N, of an oriented metal for cases in which the grain orientation was represented by texture coefficients (TC), area weighted p values, and a continuous orientation distribution function $P(u,\phi)$. The equations derived for the thermal expansion coefficient were tested on uranium rods rolled to various reductions of area at temperatures of 300 and 600°C. Thermal expansion coefficient values measured by dilatometer were in good agreement with those calculated from the derived equations except in the case where the grain orientation was represented by texture coefficients. The poor agreement in this case was believed to be due to the fact that TC values give disproportionate weight to strong textures. Studies were also made of the effect of the number of planes (hkl) employed to represent the grain orientation versus the agreement between calculated and measured thermal expansion coefficient values. Only small differences were observed between measured and calculated thermal expansion coefficient values in cases where the grain orientation was represented by 10, 14, 18, 20, and 32 measured planes. The differences were more likely due to scatter in the experimental measurements of preferred orientation than to the number of diffraction planes employed to represent the grain orientation. (auth)

952 (GA-5620) A PROGRAM OF BASIC RESEARCH ON MECHANICAL PROPERTIES OF REACTOR MATERIALS. Quarterly Progress Report for the Period Ending July 31, 1964. R. H. Chambers and T. A. Trozera (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Aug. 26, 1964. Contract AT(04-3)-167. 23p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The deformation of niobium, molybdenum, tantalum, and tungsten crystals is studied with respect to damping spectra, dislocation dynamics, annealing effects, aging effects, plastic strain, purity, and mechanical properties. (N.W.R.)

953 (GEAP-4446) A REVIEW OF FRACTURE MODES AS RELATED TO PRIMARY COOLANT SYSTEM RUPTURE STUDY. A. J. Brothers, L. F. Coffin, Jr., H. H. Klepfer, J. R. Low, Jr., and M. B. Reynolds (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). May 1964. Contract AT(04-3)-189. 78p. Dep. (mn); $3.00(cy), 2(mn) OTS.

A review of fracture modes and fracture mechanics was performed in a study on the likelihood of pipe ruptures in water-cooled reactor systems. The fracture review was primarily a materials approach to the problem. Following a definition of the finite number of known fracture modes and a delineation of the specific materials, components, and operating conditions of interest, the state of present knowledge of each fracture mode was related to the reactor piping case; the application of fracture mechanics to the pipe rupture question was also studied. The findings of these reviews were illustrated by application to specific components of typical examples of water-cooled reactor piping systems. The review leads to the following conclusions: (a) With the proper application of present knowledge, fracture by fibrous ductile fracture due to gross overstress or by brittle cleavage can be virtually ruled out as credible events, unless cyclic strain aging is found to raise the brittle-ductile transition temperature above the service temperature for carbon steels. (b) With the proper application of present knowledge, fracture by creep-rupture at 500-650°F can be virtually ruled out, although combined creep-fatigue should be further studied with respect to superheat plant piping. (c) Relationships exist which could be used to eliminate any possibility of impact erosion failures if the critical velocity parameters were determined for the specific piping steels. (d) The remaining possible fracture modes: fatigue, low-energy ductile fracture, and localized corrosion cracking, are not well enough understood to be able to predict complete immunity from their occurrence. Important questions which cannot be answered on the basis of present knowledge are: (a) Whether long, shallow, crack-like defects can develop undetected due to fatigue or localized corrosion, and whether such defects, if developed, could propagate to large-area fractures by unstable ductile rupture. (b) Whether the time for serious fatigue or corrosion crack (or leak) propagation, in the specific materials of interest, is fast or slow compared to the inherent response time for flaw and leak detection procedures. (c) Whether service experience thus far, and short-term experimental results showing freedom from localized corrosion fracture, can be taken to imply complete immunity from attack over a 10- to 40-year service exposure. The implications of this review of fracture modes were supported by the results of other tasks of the Pipe Rupture Study. The combined results were taken as the basis for recommending areas of needed development work. (auth)

954 (HW-80841) DENSITY DETERMINATIONS OF PLUTONIUM. R. D. Nelson, C. R. Becker, T. K. Bierlein, and F. E. Bowman (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Feb. 1964. Contract AT(45-1)-1350. 27p. Dep.; $2.00(cy), 1(mn) OTS.

Precise densities of plutonium can be readily obtained between −100 and 150°C using inert fluorochemicals as the displacement medium. Relatively precise densities can be obtained between 150 and 250°C with a silicone fluid as a displacement medium in an inert atmosphere. A detailed procedure for routine density determinations with Invar and gold as the known standards is discussed. Changes in the density of plutonium with time prohibit the use of a plutonium standard in the determination of densities of unknown plutonium specimens. (auth)

955 (IS-757) INFLUENCE OF RATE OF LOADING ON THE TENSILE PROPERTIES OF NORMAL ALPHA URANIUM. Philip Arthur Loretan and Glenn Murphy (Ames Lab., Ames, Iowa). Aug. 1963. Contract W-7405-eng-82. 67p. Dep.; $3.00(cy), 2(mn) OTS.

Forty tensile tests were carried out on normal alpha uranium in order to determine the influence of the rate of loading and temperature on its tensile properties. These tests were conducted at eleven different temperatures in the temperature range from 25 to 600°C for three constant loading rates (0.0017 min^{-1}, 0.0130 min^{-1}, and 0.0400 min^{-1}). The properties considered were tensile strength, per cent elongation (in 1.5 in. gage length), percentage reduction in area, yield strength, and modulus of elasticity. All of these properties were more strongly affected by a change in temperature than they were by a change in rate of loading. Graphs showing data for each of the five properties vs temperature and also as a function of rate of loading are displayed to indicate specific effects. Original stress-strain curves are included along with graphs indicating the slopes of each of these curves (subsequent to the initial elastic strain portion) as a function of temperature and rate of loading. (auth)

956 (LA-3140-MS) AN ELECTRON-MICROGRAPHIC STUDY OF ALPHA PLUTONIUM FRACTURE SURFACES. S. E. Bronisz and Dana L. Douglass (Los Alamos Scientific Lab., N. Mex.). Aug. 1964. Contract W-7405-eng-36. 40p. Dep.; $2.00(cy), 1(mn) OTS.

The fracture behavior of alpha plutonium has been studied using electron microfractography. Standard techniques were employed for producing the highly contaminated replicas, and they were handled using techniques previously worked out for handling alpha radioactive metallographic specimens. For high-purity alpha plutonium, the fracture mode is temperature dependent with an equicohesive temperature between 191 and 297°K. Below this temperature, alpha plutonium fractures in a ductile, transgranular manner, while above it fractures are intergranular. The appearance of the fracture surface is modified by the presence of impurities. (auth)

957 (MCW-1487) EQUILIBRIUM STRUCTURES IN THE HIGH URANIUM−IRON ALLOY SYSTEM. Topical Report. J. A. Straatmann and N. F. Neumann (Mallinckrodt Chemical Works. Uranium Div., Weldon Spring, Mo.). Nov. 6, 1964. Contract W-14-108-eng-8. 26p. Dep.; $2.00(cy), 1(mn) OTS.

The boundaries and phase fields existing in uranium alloys containing from 400 to 5000 ppm by weight iron at temperatures from 600 to 1200°C have been determined from differential thermal, metallographic, and microprobe analyses. The phase diagram and the methods used to determine it are included as well as micrographs of the studied specimens. The retention of beta-uranium at room temperature and the occurrence of a subgrain network are also discussed and micrographs of these phenomena are shown. (auth)

958 (NAA-SR-9260) CRYSTALLOGRAPHIC EXPANSION OF BeO AT THE ALPHA-BETA BeO TRANSFORMATION TEMPERATURE. S. B. Austerman (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Oct. 15, 1964. Contract AT(11-1)-Gen-8. 9p. Dep.; $1.00(cy), 1(mn) OTS.

A phase transformation has recently been demonstrated in BeO at about 2050 to 2100°C. Crystallographic expansion associated with this transformation has been measured by x-ray diffraction and by visual measurement with a traveling microscope. By the latter method, it was determined that expansion parallel to the c-axis was 5.9 ± 1.0%, and normal to the c-axis it was 0.0 ± 1.0%. By x-ray diffraction from single crystals, expansion was measured to be 6.1 ± 0.3% parallel to the c-axis, and −0.9 ± 0.3% normal to the c-axis. (auth)

959 (ORNL-3676(p.9-11)) THEORY OF METALS. (Oak Ridge National Lab., Tenn.).

An l-dependent psuedopotential for the scattering of conduction electrons in lithium is calculated. For $l \neq 0$, the screened Hartree field of the ion core is obtained, while for s waves there is an extra repulsive term originating from exclusion principle requirements. Abstracts of published papers on the electrical resistivity of alkali vapors at high densities, the theory of the coercive force for randomly distributed lattice defects and precipitations in ferromagnetic materials, and the theory of inelastic neutron scattering of metallic electrons in the one-electron approximation are given. (auth)

960 (ORNL-3676(p.32-4)) ELECTRON MICROSCOPY. (Oak Ridge National Lab., Tenn.).

High-resolution studies leading to the resolution of periodic structures in solids are reported, and examples are shown of lattice planes in MoO_3 and the antiphase structure of Cu−Au VI. Abstracts of papers submitted for journal publication on electron microscopy of fission fragment damage in MoO_3 and phonon scattering by the F-center electron are given. (R.E.U.)

961 (ORNL-3676(p.51-60)) INVESTIGATIONS OF METAL SURFACES. F. W. Young, Jr., L. D. Hulett, L. H. Jenkins, U. Bertocci, and J. R. Savage (Oak Ridge National Lab., Tenn.).

SURFACES OF COPPER IN SOLUTIONS CONTAINING COPPER SULFATE. Over a period of months, no differences in electrochemical equilibrium potentials could be measured, nor were preferntial orientations developed on any surface. It was concluded that no orientation was thermodynamically more stable than any other. Pits and facets developed on surfaces undergoing very slow reaction were examined, and some postulates concerning the nucleation and motion of steps on variously oriented surfaces were made. Initial high slopes in potential vs current curves in systems also corroding at a very low rate lead to false conclusions concerning equilibrium potentials between orientations. KINETICS OF PIT FORMATION AND LEDGE MOTION DURING THE DISSOLUTION OF (111) SURFACES OF COPPER. A detailed description of ledges and pits formed on the surface undergoing dissolution and their motion is presented. A unified explanation involving kinematic mechanistics is advanced. ELECTROCHEMICAL STUDIES OF COPPER SINGLE CRYSTALS IN HALIDE SOLUTIONS. Potentials at zero current density for different orientations differed mainly because of kinetic parameters. Faceting due to either chemical or electrochemical processes was not found to be different. Preliminary differential capacitance measurements are discussed. Differences and similarities to chloride solutions are discussed. OBSERVATIONS OF DISLOCATIONS IN COPPER, USING BORRMANN X-RAY TRANSMISSION TOPOGRAPHS. Abstract of paper to be submitted for journal publication. GROWTH OF COPPER CRYSTALS OF LOW DISLOCATION DENSITY. Abstract of paper submitted for journal publication. (auth)

962 (ORNL-3679(p.88-93)) NONAQUEOUS SYSTEMS AT HIGH TEMPERATURES. (Oak Ridge National Lab., Tenn.).

In pursuance of the study of mixtures of metals with molten salts, the electrical conductivity and cryoscopic behavior of the solutions of Sr and Ba in their respective

chlorides, bromides, and iodides were determined. Sr was shown to behave similarly to Ca and to Na. The decrease in metal solute conductivity with increasing metal concentration indicates the trapping of mobile electrons in pairs in the form of alkaline-earth molecule ions, M_2^{3+}, analogous in electronic structure to the diatomic sodium molecules, Na_2. Barium metal solutions, however, resemble the K systems with less stable $K_2(Ba_2^{3+})$ in showing high metal solubility and an increase in solute conductivity with solute concentration. Correlation of electronic conductivity with the product of electron and metal ion concentrations is discussed. The phase diagrams of the systems barium bromide (or iodide)–barium metal were determined. Miscibility of salt and metal is much greater than in Ca systems. It increases in going from the chloride via the bromide to the iodide system in correspondence with the decrease in the interionic binding force with increasing size of the halide ion. The critical solution temperature drops from 1018 to 960 and to 914°C respectively. The solubility of the metal in the salt at the consolute temperatures increases from 54 to 62 and 70 mole %, as expected from the increase in the molar volume of the salt. The solubility of Ca metal in solid CaF_2 was found to increase to slightly more than 2 mole % metal on reaching the monotectic temperature of 1290°C. These data allow an interpretation of the CaF_2–Ca liquidus in terms of an equilibrium between mobile electrons and diatomic Ca_2 molecule ions in the molten solution similar to that in other Ca metal–Ca halide melts, as well as to the equilibrium $Na_2 \rightleftharpoons 2Na^+ + 2e^-$ in Na metal–Na halide melts. (auth)

963 (ORNL-P-499) PARAMETER MEASUREMENTS IN THIN DIELECTRIC FILMS. J. V. Cathcart (Oak Ridge National Lab., Tenn.). Sept. 22, 1964. Contract W-7405-eng-26. 8p. (CONF-769-1). Dep.(mn); $1.00(cy), 1(mn) OTS.

From Conference on Electrical Insulation, Cleveland, Oct. 1964.

The advantages and disadvantages of ellipsometry (reflection of elliptically polarized light) and x-ray diffraction for studying thin films are outlined. Problems encountered in the use of ellipsometry are illustrated by the results of a study of thin Cu_2O films on Cu single crystals; rotation of the crystal about its surface normal produced periodic changes in the apparent film thickness for the (311) and (110) planes, but not for the (100) and (111) planes. This oxide anisotropy varied with film thickness, with a maximum occurring at ~300 Å. An optical model of the oxide film was developed in which epitaxial stresses are accounted for by a series of layers of differing refractive index; the calculations agree with ellipsometer data. (D.L.C.)

964 (SC-TM-357-63(13)) PROPERTIES OF FERROELECTRIC CERAMICS UNDER HIGH STRESSES (AXIAL MODE). A. E. Binder (Sandia Lab., Albuquerque, N. Mex.). Feb. 1964. Contract AT(29-1)-789. 40p. Dep.(mn); $2.00(cy), 1(mn) OTS.

Some of the electrical properties of ferroelectric ceramics have been measured over a range of stresses from about 2 to 500 kilobars. The charge release was found to depend on stress for both a modified barium titanate and a 95/5 lead zirconate titanate ceramic, with optimum characteristics in the neighborhood of 20 kilobars for barium titanate and 10 kilobars for the 95/5 lead zirconate titanate. It was found that conductivity induced by stress was the cause of less than full charge release. The conductivity and high frequency permittivity (~1 megacycle) were measured under the test conditions. (auth)

965 (TID-21218) OBSERVATIONS OF THE INITIATION OF FRACTURE IN ALUMINUM–SILICON ALLOYS. Technical Report No. 8. A. Gangulee and J. Gurland (Brown Univ., Providence). Sept. 1964. Contract AT(30-1)-2394. 20p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The cracking of silicon particles, during the early stages of deformation of Al–Si alloys, occurs progressively over a range of stress. The fracture probability of the particles is proportional to a stress-structure parameter: $\sigma(d^{1/2}/t^{1/2})$, based upon a simple dislocation model. The experimental evidence indicates preferred cracking of the larger particles and, in general, supports the view that cracks in the silicon particles are preceded by slip in the matrix. (auth)

966 (TID-21221(p.111-54)) THE CAUSES OF EMBRITTLEMENT IN STEELS FOR NUCLEAR REACTOR VESSELS. Jean Sebille (European Atomic Energy Community).

A study was made of various forms of embrittlement in reactor-vessel steels. The forms include those caused by welding, stress-relieving annealing, mechanical stresses, and these peculiar to welds in thick plates. The use of high-purity steels to reduce embrittlement is considered. (D.L.C.)

967 (UCRL-7833) COMPRESSIBILITY OF LIQUID HYDROGEN TO 40,000 ATMOSPHERES AND 1100°K. M. Van Thiel and M. Wasley (California. Univ., Livermore. Lawrence Radiation Lab.). Mar. 1964. Contract W-7405-eng-48. 30p. Dep.; $2.00(cy), 1(mn) OTS.

Liquid hydrogen with an initial density of 0.0710 g/cm³ at 20.5°K was compressed to a density of 0.192 g/cm³. Using available thermodynamic data, a calculation of the Hugoniot path was made which showed that the compressibility is higher than would be expected from the commonly useful linear extrapolation of the Hugoniot curve in the shock-particle velocity plane. Further calculations of the melting lines in the PV plane and the heat capacity showed that the Hugoniot path was completely in the liquid phase and that the temperature of the compressed fluid was 1100°K. Uncertainties in estimating thermodynamic data in the range where measurements are lacking are discussed in line with these calculations, and further experimentation is suggested. (auth)

968 (UCRL-12029-T) DIFFUSION IN MAGNETIC MATERIALS. R. J. Borg (California. Univ., Livermore. Lawrence Radiation Lab.). Aug. 20, 1964. Contract W-7405-eng-48. 15p. (CONF-691-2) Dep.(mn); $1.00(cy), 1(mn) OTS.

From Conference on Fusion of Body-Centered Cubic-Materials, Gatlinburg, Tenn., Sept. 1964.

The diffusivity in several ferromagnetic metals and alloys decreases more rapidly with decreasing temperature in the vicinity of the Curie temperature than predicted by the Arrhenius relationship. This departure from a linear relation, called the "magnetic effect," is illustrated by results for Fe in α-Fe and Fe–V. Short-range order of spins is discussed. Experiments in which the magnetic effect was observed are reviewed. The possible causes of the magnetic effect are discussed in terms of absolute rate theory. It is concluded that while the decrease in vacancy concentration also contributes to the magnetic effect, the change in elastic properties is the dominant cause. (D.L.C.)

969 (UCRL-12039) STUDIES IN MECHANICS OF NONLINEAR SOLIDS (thesis). Richard Dong (California. Univ., Livermore. Lawrence Radiation Lab.). June 1964. Contract W-7405-eng-48. 128p. Dep.; $4.00(cy), 3(mn) OTS.

Constitutive equations for nonlinear materials with memory have recently been formulated by a number of authors; among these are Green, Rivlin, and Spencer, Noll, Coleman and Noll, and Hermann. In each case, stress is expressed as a tensor functional of the strain history. A functional can be thought of as a mapping of a set of functions onto another set of functions, the mapping being characterized by kernels appearing in the series expansion of the functional. In solid mechanics the functional equations are the constitutive equations of a material, and the kernels are material functions. In a nonlinear constitutive equation the material functions have multiple time arguments. Before constitutive equations can be used in analysis, the material functions must be evaluated. This is a difficult task when multiple time argument functions are involved. Sev-

eral authors have proposed simplifications motivated by observed behavior of certain real materials and have proposed, and in some cases performed, experiments for measuring the simplified material functions. These authors include: Nakada; Leaderman, McCrackin, and Nakada; Ward and Onat; Ko and Blatz; and Lianis. The simplifying assumptions that were made include one or more of the following: assuming Coleman and Noll's finite linear constitutive equation is applicable, assuming the material is incompressible, and assuming separability of the multiple time argument material functions with respect to each time argument. One-dimensional constitutive equations were used by some of the authors. In none of the papers was there a complete study of the multiple time argument material functions without some simplifying assumptions. It is desirable to have a method for completely evaluating multiple time argument material functions without a priori simplifications. The primary purpose of the dissertation is to present such a method. In the process, some light is shed on the physical meaning of multiple time argument material functions. Among the most important results found are the following: Formally, an infinite number of experiments is required to completely evaluate a multiple time argument function, and while the "weighing" of the strain history is independent of the history itself for a linear material function, this is not true for nonlinear multiple time argument functions. The difficulties involved in conducting a very large number of experiments can be avoided by performing only a finite but properly planned set of experiments to characterize the functions. The constitutive equations used in the dissertation describe only physically nonlinear behavior. This is merely a simplification of kinematics and does not detract from the usefulness of the method for studying material functions for geometrically nonlinear constitutive equations. (auth)

970 (AEC-tr-6510) REACTIVITY OF DIFFUSION OF CARBON INTO TUNGSTEN. G. S. Kreimer, L. D. Efros, and E. A. Voronkova. Translated by J. F. White from Zh. Tekhn. Fiz., 22: 858-83(1952). 25p. Dep.(mn); $1.00(cy) 1(mn) OTS; $2.60(fs), $0.95(mf) JCL.

In experiments on heating of polycrystalline W rods with C in a H_2 stream at 1500 to 1800°C, it was found that a WC phase first appears, through which C diffuses into the W to form W_2C. The time dependency of the growth of the W_2C diffusion layer was determined, and the following equations were derived: $D(C_1 - C_2) = 2750\ e^{-56,000/T}$ and $D = 25,000\ e^{-56,000/T}$. The process of carbonization of carbon and diffusion along grain boundaries and free surfaces were studied. (D.L.C.)

971 (JPRS-26808(p.169-82)) NEUTRONOGRAPHIC INVESTIGATIONS IN THE REACTOR. V. N. Bykov, S. I. Vinogradov, V. S. Golovkin, V. V. Kazarnikov, V. A. Levdik, and Yu. V. Shumov. Translated from p.199-214 of "10 Let Pervoy v Mire Atomnoy Elektrostantsii SSR."

Thermal neutron beams from the reactor were used to investigate the arrangement of carbon atoms in the lattice of austenite, the structure of the delta-hydride of zirconium, the ordering in the structure of the sigma-phase of chromium-iron alloys, and the antiferromagnetic structure of chromium. (C.E.S.)

972 STUDY OF THE BINARY DIAGRAMS $\alpha - Fe_2O_3 - NiO$ AND $La_2O_3 - NiO$ AND THE TERNARY DIAGRAM $\alpha - Fe_2O_3 - NiO - La_2O_3$. Jeannine Cassedanne (Université, Strasbourg). Anais Acad. Brasil. Cien., 36: 13-19(1964). (In French)

The binary diagrams $\alpha - Fe_2O_3 - NiO$ and $La_2O_3 - NiO$ were established up to temperatures of 1550°C. The ternary diagram $\alpha - Fe_2O_3 - La_2O_3 - NiO$ was studied at the isotherms of 800, 1000, 1300, and 1400°C. The quasi-binary sections are given. (tr-auth)

973 STRUCTURE OF ZIRCONIUM OXIDE FILMS. F. Barbesino, R. Di Pietro, G. Perona, and R. Sesini (Laboratori CISE, Milan). Energia Nucl. (Milan), 11: 567-70(Oct. 1964).

Zircaloy-2 samples are oxidized in autoclaves at 290°C for various durations, producing oxide layers 3000 to 7000 Å thick. It is concluded that the oxide film is composed of crystals born on the crystalline grains of the metal, and that the crystal structure and orientation of the oxide lattice is closely allied to that of the underlying metal, for film thicknesses below about 5000 Å. Above this thickness, the film takes on a disordered polycrystal line structure throughout its thickness. (T.F.H.)

974 ACTIVATION ENERGY OF RECOVERY IN COLD-WORKED TUNGSTEN DERIVED FROM MEASUREMENT OF X-RAY LINE BROADENING. Seizo Nakajima and Hiroshi Okazaki (Matsushita Electronics Corp., Osaka). J. Appl. Phys., 35: 3419-20(Nov. 1964).

The activation energy of recovery in cold-worked (pure and $K_2O - SiO_2 - Al_2O_3$ doped) tungsten wires was determined by measuring the x-ray line broadening. For the doped wire, the activation energy was 2.30 ev, increasing gradually above 700°C. For the pure wire, the activation energy was 1.94 ev at 400 to 600°C and more than 2 ev above 650°C. (D.C.W.)

975 ELECTRON MICROSCOPE OBSERVATIONS OF THE CRYSTALLIZATION OF ANODICALLY FORMED TANTALUM AND NIOBIUM OXIDE FILMS. R. E. Pawel and J. J. Campbell (Oak Ridge National Lab., Tenn.). J. Electrochem. Soc., 111: 1230-4(Nov. 1964).

Anodic oxide films ranging in thickness from about 200 to 1000Å were formed on electropolished surfaces of tantalum and niobium by conventional techniques. The films were then stripped from the metal, given a variety of thermal treatments in vacuum, and examined directly in the electron microscope. Crystallization of the amorphous films was induced by high-temperature annealing or in the microscope itself by increasing the beam intensity. The distinguishing features of each type of crystallization process are discussed and illustrated with appropriate micrographs. (auth)

976 CRITICAL PHENOMENA WITH THORIUM ADSORBED ON SINGLE-CRYSTAL TUNGSTEN. J. Anderson and W. E. Danforth (Franklin Inst., Swarthmore, Penna.). J. Electrochem. Soc., 111: 1297-8(Nov. 1964).

Studies were made on the work function variation and thermal desorption for the adsorbed monolayer system thorium-on-tungsten. The work was concerned with $f > 1$, the variation of work function with thorium coverage, $\phi(f)$, the thermal desorption of thorium from the surface, and the surface migration of thorium atoms (observable only qualitatively). The results showed that from a ϕ of 4.42 ev (essentially constant over the temperature range involved, 1100–1360°K), ϕ decreases to a minimum (ϕ_{min}) of 3.08 ev at a thorium coverage of 4.2×10^{14} at./cm^2. By the shutter method it was found that the thorium migrates very rapidly at $f \geq 1.65$ for all temperatures in the range. Below $f = 1.65$ no such migration could be detected at all at low temperatures (T/1250°K). It was found that the average desorption rate for concentrations greater than $f = 1.7$ is approximately 1 f-unit in 10 min, fifteen times as great as the rate at $f = 1.4$. (P.C.H.)

977 EVAPORATION AND DIFFUSION PHENOMENA IN THORIA COATED CATHODES. R. O. Jenkins and W. G. Trodden (General Electric Co. Ltd., Wembley, Eng.). J. Electron. Control (1), 17: 273-82(Sept. 1964).

Evaporation from a thoria coated tungsten filament for the temperature range 1900–2300°K was studied by measuring the thermionic emission of a nearby tungsten receiver. Below 2100°K the evaporated product was mainly thoria with a small amount of thorium. Above 2100°K there was an increased proportion of thorium. The thermionic emission of thoria coated iridium was studied after evaporating thoria from a source on to the clean metal. After only a few monolayers were deposited on the iridium the thermionic emission decreased during operation below 2200°K due to diffusion of thorium into the metal. Later when more thoria was deposited a relatively high and stable thermionic emission was obtained following operation of the

iridium at 2400°K. This is explained by assuming that at 2400°K considerable crystal growth occurred and that the thorium was stored in the grain boundaries. (auth)

978 INTERDIFFUSION IN ZIRCONIUM–ALUMINUM AND ZIRCALOY–ALUMINUM SYSTEM. G. P. Tiwari and B. D. Sharma (Atomic Energy Establishment, Trombay, India). Nature, 204: 178-9(Oct. 10, 1964).

Certain features of layer growth in Zr–Al and Zircaloy–Al alloys, which are presumably affected by rate constants, are reported. Metallographic and x-ray examination of both Zr–Al and Zircaloy–Al couples revealed the presence of only two phases in the diffusion zones, which were identified as $ZrAl_3$ and Zr_2Al. The $ZrAl_3$ phase, nearer to Al, was found to be relatively more predominant and also more brittle. Investigations showed that the atomic mobility of Al atoms is higher than that of Zr atoms. The $ZrAl_3$ lattice is fcc tetragonal ($a = 4.013$, $c = 17.321$ Å) with presumably larger interstitial holes. As such the predominance of $ZrAl_3$ in the diffusion layer can be attributed to the interstitial diffusion of Al atoms in the $ZrAl_3$ lattice. The results indicate faster interdiffusion in Zircaloy–Al as compared with the Zr–Al system. (P.C.H.)

979 CRYSTAL STRUCTURE VARIATIONS IN ALPHA URANIUM AT LOW TEMPERATURES. M. H. Mueller (Argonne National Lab., Ill.), R. L. Hitterman, and C. S. Barrett. Phys. Rev., 129: 625-9(1963). (DP-904(p.125-6))

A study was made of atom positional parameter, unit cell dimensions, and thermal expansion coefficients of alpha uranium at temperatures from 298 to 4.2°K. (D.L.C.)

980 SELF-DIFFUSION AND NUCLEAR QUADRUPOLAR RELAXATION IN FCC LANTHANUM METAL. David Zamir and D. S. Schreiber (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 136: A1087-90(Nov. 16, 1964).

The nuclear magnetic-resonance spin-lattice (T_1) and spin-spin (T_2) relaxation times and the Knight shift of ^{139}La in pure fcc lanthanum metal were studied from 295 to 825°K. The relaxation times exhibit a temperature dependence which can be explained by vacancy diffusion and annealing effects that perturb the spin system via the nuclear electric-quadrupole interaction. At the highest temperatures, it is found that $T_1 = T_2 \propto \exp(E_a/kT)$ where $E_a = 15$ kcal/mole is found for the activation energy of vacancy formation and diffusion. The Knight shift is found to increase from 0.64% at 295°K to 0.72% at 825°K, which may be the result of an electron-phonon interaction. (auth)

981 KNIGHT SHIFTS AND SUSCEPTIBILITIES OF TRANSITION METALS: PALLADIUM. J. A. Seitchik, A. C. Gossard, and V. Jaccarino (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., 136: A1119-25(Nov. 16, 1964).

The nuclear magnetic resonance (NMR) of ^{105}Pd was observed for the first time. The temperature dependence of the ^{105}Pd NMR in palladium metal was studied in the region 1.4 to 300°K. The relatively large linewidth ($\delta H = 9 \pm 2$ Oe) at all temperatures necessitated the use of continuous averaging techniques to obtain the requisite sensitivity. The field for resonance, at a fixed frequency, was found to have a maximum in the vicinity of 85°K, as does the susceptibility $\chi(T)$. From an analysis of the temperature dependence of the Knight shift $K(T)$ and of $\chi(T)$ it was deduced that: d-spin paramagnetism is responsible for the observed behavior of $K(T)$ and $\chi(T)$, the principle contribution to K in Pd arises from d-spin-induced core polarization, and the core-polarization hyperfine field $H_{cp} = -689 \pm 20$kOe/spin. From a partitioning of the various contributions to K, χ, and the specific heat, an estimated value of $1/T_1 \simeq 0.8T$ sec^{-1}°K is obtained for the nuclear spin-lattice relaxation rate at low temperatures. It is shown that the knee in $\chi(T)$ is not associated with a static antiferromagnetic ordering; an upper limit of 10^{-5} μB per Pd atom for the spontaneous moment at low temperatures is obtained. A diamagnetically uncorrected value of the ^{105}Pd nuclear moment $\mu^{105} = -0.639 \pm 0.003$ nm was determined. (auth)

982 MEASUREMENT OF THE EQUILIBRIUM NET VACANCY CONCENTRATION IN SODIUM. George A. Sullivan and John W. Weymouth (Univ. of Nebraska, Lincoln). Phys. Rev., 136: A1141-8(Nov. 16, 1964).

Simultaneous measurements of length and lattice thermal expansions were made on two single-crystal rods of sodium, over a temperature range of –26°C to near the melting point of 97.8°C. The relative length changes were measured by means of two filar micrometer microscopes, and the lattice parameter changes were measured by a back-reflection, translated-sample method. The length and lattice expansions begin to diverge at approximately 10°C, with least-squares-fitted curves leading to a net atomic fraction of vacancies at the melting point of $(0.94 \pm 0.11) \times 10^{-6}$ and $(0.66 \pm 0.15) \times 10^{-6}$ for the two samples. These values are lower than some that exist in the literature but agree with one set of electric resistivity measurements and with one set of specific-heat measurements. In the latter case, anharmonic contributions were subtracted from the specific-heat data before arriving at a defect concentration. Proceeding on the assumption that only vacancy formation is present, energies of 0.157 ± 0.014 and 0.117 ± 0.023 ev were obtained by fitting straight lines to semilog plots of the concentration versus reciprocal temperature. These values are lower than any existing in the literature with the possible exception of that of one set of electric resistivity measurements. Entropies of formation were also calculated by extrapolating the plots to infinite temperature. These appear to be negative well within the errors. It is quite possible that interstitial formation is present, thus lowering the semilog plots at the high-temperature end and giving erroneously low and negative entropies. Thus these values may be less meaningful than the values for melting-point concentrations. A value is given for the lattice parameter of sodium at 25°C, and the fitted thermal expansion coefficients are presented. (auth)

983 DISORDER RESISTIVITY OF BINARY RARE EARTH ALLOYS. A. J. Dekker (Universität, Groningen, Netherlands). Phys. Status Solidi, 7: 241-53(1964).

Expressions are derived for the disorder resistivity of binary rare earth alloys at temperatures above the magnetic transition point and at absolute zero. Only ferromagnetic alloys are considered. The treatment is based on a Nordheim approximation, extended to incorporate spin-dependent scattering. The theoretical expressions are in satisfactory agreement with experimental data for Gd–Lu, Tb–Lu, Gd–Y, and Gd–Er alloys. (auth)

984 PREPARATION AND PROPERTIES OF VAPOR-DEPOSITED NIOBIUM STANNIDE. J. J. Hanak, K. Strater, and G. W. Cullen. RCA Rev., 25: 342-65(Sept. 1964).

This paper gives a review of work carried out on the vapor deposition of Nb_3Sn. Techniques are described for depositing Nb_3Sn by simultaneous hydrogen reduction of gaseous niobium and tin halides on various substrates, including narrow and wide metallic ribbons and flat and cylindrical ceramics. These deposits are useful in the construction of high-field magnets and in research and applications where the presence of metallic substrates is undesirable. In the case of metallic substrates, platinum and other noble metals have been found to aid in the nucleation of Nb_3Sn, but deposits have been successfully prepared on various high-strength nickel-base alloys. For ceramics, adherent Nb_3Sn has been deposited on magnesium silicates. The chemistry of the vapor deposition process has been studied in some detail. Nb_3Sn can be formed at temperatures ranging from 675 to at least 1600°C. It has been found that the Nb_3Sn phase can be deposited over a composition range of 75.1 to 82.3 at. % Nb. The corresponding lattice constants and transition temperatures have been determined over this range of compositions. The effect of the concentration of the reacting gases and temperature on the composition of the deposit has been determined. The equilibrium constant for the deposition reaction has been found to increase with temperature and its value at 950°C is about 5×10^{-3}. (auth)

985 RESEARCH ON THE METALLURGY OF NIOBIUM AT THE UNIVERSITY OF SHEFFIELD. B. B. Argent (Univ. of Sheffield, Eng.). Sci. Progr. (London), 52: 608-27(Oct. 1964).

Discussion is presented on work now in progress at Sheffield on the rate-controlling mechanisms in the creep of niobium alloys, the mode of precipitation of niobium carbide on stacking faults present in austenitic steels, and the growth of ferrite grains in mild steels when niobium carbide is present. Special attention is given to research concerned with the use of niobium in steels and superalloys, and on alloys based on niobium and of the importance in the development of alloys for service at high temperatures. (P.C.H.)

986 SOME PROPERTIES OF THE NIOBIUM–NITROGEN SYSTEM. T. S. Verkhoglayadova, S. N. Lvov, and V. F. Nemchenko (Inst. of Metalceramics and Special Alloys, Academy of Sciences, Ukrainian SSR and Kherson Pedagogical Inst., USSR). Ukr. Khim. Zh., 30: 667-70 (1964). (In Russian)

Phase diagrams were constructed for Nb–N systems. Studies were made of the microhardness, ductility, density, thermoelectric force, thermal and electric conductivities, and Hall constants. (R.V.J.)

987 CRYSTAL STRUCTURE INVESTIGATIONS IN SOME ALLOY SYSTEMS HOMOLOGOUS AND QUASI-HOMOLOGOUS TO T^6-T^{10}. Alfonso Maldonado and Konrad Schubert (Max-Planck-Institut fur Metallforschung, Stuttgart). Z. Metallk., 55: 619-26(Oct. 1964). (In German)

Several systems were investigated by crystal structure analysis: vanadium–nickel, vanadium–palladium, niobium–palladium, tantalum–palladium, vanadium–platinum, niobium–platinum, tantalum–platinum, molybdenum–palladium, and molybdenum–platinum. Crystal structures of the types AuCd, $MoPt_2$, and $TiAl_3$ occur frequently. These structures consist of closely related elements, which are stacked differently. The geometrical relation of the order in the elements makes it probable that the T^6-atoms show long-range interactions with each other and in this way select only certain possibilities of coördination. A new interpretation of the so-called K-state may arise from these results. (auth)

988 STUDIES OF METAL INTERDIFFUSION BY ATTENUATING RADIOACTIVE EMISSION. A. Ya. Shinyaev, V. V. Bondarev, and M. S. Cherneko (State Inst. on Nitrogen Industry, Severodonetsk, USSR). Zavodsk. Lab., 30: 1106-9(1964). (In Russian)

A method is suggested for investigating the composition of diffusion zones by narrow beam attenuation. Data are given on the diffusion of titanium in molybdenum and nickel. (tr-auth)

Radiation Effects

Refer also to abstract 1506.

989 (AERE-M-760) HEATING BY THERMAL-NEUTRON CAPTURE IN NON-FISSILE MATERIALS. W. R. Hobbs (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Sept. 1960. 11p. Dep.(mn).

An attempt is made to collect together all the information required to make estimates of neutron-capture heating in materials in general use. A method of working is given which with this data should meet the high accuracy required by present designs of in-pile equipment. (auth)

990 (BNL-8418) EFFECT OF NEUTRON IRRADIATION ON PRECIPITATION OF CARBON IN ALPHA-IRON. A. C. Damask (Brookhaven National Lab., Upton, N. Y. and Frankford Arsenal. Pitman-Dunn Lab., Philadelphia). [1964]. Contract AT-30-2-GEN-16. 20p. (CONF-691-4). Dep.(mn); $1.00(cy), 1(mn) OTS.

From Conference on Fusion of Body-Centered Cubic-Materials, Gatlinburg, Tenn., Sept. 1964.

Neutron irradiation of an alloy containing a solute in interstitial positions can produce sites for heterogeneous nucleation of the precipitates and traps for the diffusing interstitials which retard the precipitation. These two effects were studied in the Fe–C system by internal friction, electrical resistivity, electron microscopy, and calorimetry measurements. The probable sequence of defect migrations following low-temperature irradiation and their effect on the precipitation of carbon are described. (D.L.C.)

991 (CEA-R-2510) ETUDE DE L'INFLUENCE DU SPECTRE DES NEUTRONS RAPIDES SUR LA CREATION DE DEFAUTS DANS LES SOLIDES ET LES LIQUIDES. (Study of the Influence of the Fast Neutron Spectrum on the Formation of Defects in Solids and Liquids). P. Mas and Y. Droulers (France. Commisariat à l'Énergie Atomique. Centre d'Études Nucléaires, Grenoble). Apr. 21, 1964. 30p. Dep.(mn).

In the first part of this work a calculation has been made of the number of defects formed in graphite by a given neutron flux having various spectral distributions. The defect formation function is that of KINCHIN and PEASE; its formulation is briefly given. An efficiency function is then defined for a fast neutron spectrum. This defects produced in a light water reactor and those produced in a graphite reactor. Finally an application of this method is given for comparing the defect forming tendency in graphite in the case of the reactor MELUSINE and of the reactor G2 and G3. In the second part are calculated the integrals for the energy release brought about by fast neutrons in carbon, oxygen, and hydrogen. In a region of 25 cm around the core of a swimming-pool type reactor these energy release integrals are approximately proportional to the neutron flux above 1 Mev. The determination of the energy released as a result of the passage of neutrons in organic liquids can therefore be reduced to the measurement of the flux above 1 Mev for the real spectral distribution. A verification has been carried out calorimetrically in the case of water. (auth)

992 (CRFD-1192) IRRADIATION BEHAVIOR OF EXTRUDED UO_2. G. H. Chalder (Atomic Energy of Canada Ltd., Chalk River, Ont.). Apr. 1964. 23p. (AECL-1990) Dep; $1.00(AECL).

Fuel elements containing two types of extruded and sintered UO_2 were irradiated in the Hydraulic Rabbit in NRX at heat ratings ($\int \lambda d\theta$) of 72–74 w/cm. Elements containing a single rod of fuel showed lower central temperature and greater uniform diametral expansion than those in which the same fuel was in the form of dished pellets. Circumferential ridges occurred in the sheaths of pellet-filled elements but not in those of rod-filled elements. The axial and diametral expansion was lower for UO_2 containing 0.2 wt % TiO_2 and 0.5% bentonite (aluminum silicate) than for UO_2 without additions, at similar heat ratings. (auth)

993 (DP-904(p.127-9)) THE FORM OF A SOLUTION FOR THE PREDICTION OF DIMENSIONAL CHANGES OF URANIUM FUEL CORES DURING IRRADIATION. P. R. Morris (National Lead Co. of Ohio, Cincinnati).

The form of a proposed solution for the prediction of dimensional changes in uranium fuel cores during irradiation is set forth. Present knowledge of relevant physical processes is reviewed. Areas are noted in which experimental data are required. (auth)

994 (GEAP-4452) AUTORADIOGRAPHY AND BURR DRILLING TECHNIQUES FOR FISSION PRODUCT MIGRATION STUDIES OF IRRADIATED UO_2. R. F. Boyle, J. P. Peterson, W. Von Ketron, and T. E. Lannin (General Electric Co. Vallecitos Atomic Lab., San Jose, Calif.). June 2, 1964. Work Performed under United States—Euratom Joint Research and Development Program. Contract AT(04-3)-189. 30p. (EURAEC-1211) Dep.(mn); $2.00(cy), 1(mn) OTS.

Uranium dioxide operated in the region of columnar grain growth or above exhibits phenomena that are not fully understood. The autoradiographic and burr drilling tech-

niques described offer valuable insight into these phenomena, especially fission-product migration. The information about fuel rod performance obtained by using these techniques complements that obtained from metallographic examination of the UO_2 fuel as well as heat-transfer calculations. (auth)

995 (HW-82400(p.8.1-11)) PLUTONIUM FUELS IRRADIATION EXPERIENCE. W. E. Roake (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Results are summarized of the irradiation experience with UO_2-PuO_2 fuel in the Plutonium Recycle Test Reactor (PRTR). The history of the PRTR fuel loading is described. Of the ~5000 irradiated conventional fuel rods, only 34 have failed in service, and the causes of these failures were studied. Some results with failed or deliberately defected fuel rods indicate that washout of particle fuels through cladding failure is not severe, owing to in-pile sintering of the particles. The Fuel Element Rupture Test Facility, which is being used in other studies, is described. It is concluded that the use of plutonium in fuels entails no performance limitations. (D.L.C.)

996 (NRL-Memo-1351) IRRADIATION EFFECTS ON STRUCTURAL MATERIALS. Quarterly Progress Report No. 1, May 1–July 31, 1962. L. E. Steele and J. R. Hawthorne (Naval Research Lab., Washington, D. C.). Contract AT(49-5)-2100. 14p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Studies on the notch ductility of irradiated steels and on the effects of postirradiation heat treatment on notch ductility behavior are being conducted. (auth)

997 (NYO-2994-1) THE BASIC MECHANISM OF RADIATION DAMAGE. Final Report. I. G. Greenfield, A. Lawley, J. D. Meakin, and H. G. F. Wilsdorf (Franklin Inst. Labs. for Research and Development, Philadelphia). Mar. 1964. Contract AT(30-1)-2994. 19p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Radiation produced structures in copper, nickel, molybdenum, and austenitic stainless steel are studied. Thin film transmission electron microscopy was the principal technique utilized. High precision density measurements were also made during the annealing-out of radiation damage in copper and molybdenum. Neutron irradiation produces both interstitials and vacancies whereas rapid quenching from high temperature produces only a supersaturation of vacancies. Pure aluminum and nickel, an aluminum–0.5% magnesium alloy and stainless steel were examined in the as-quenched and quenched-aged condition. (auth)

998 (ORNL-3676(p.12-23)) RADIATION DAMAGE THEORY. (Oak Ridge National Lab., Tenn.).

NUMERICAL CALCULATION IN THE THEORY OF RADIATION-ENHANCED DIFFUSION. A computer program was written for determining the defect concentration during irradiation for the case in which the defects may annihilate by pair recombination or by diffusion to fixed sinks. Calculations made with this program were used as a basis for analyzing the effects of radiation-enhanced diffusion in Cu–Al alloys. DIFFUSIONLESS SELF-ANNEAL IN VACANCY-INTERSTITIAL CASCADES. The problem considered is that of the annihilation of mechanically unstable vacancy-interstitial pairs formed in a displacement cascade. The amount of such self-anneal is calculated using a time-dependent absorption description in terms of multiparticle density functions. The importance of this general method lies in the possibility of including spatial correlations of pairs of defects. THEORETICAL STUDIES OF ISOCHRONAL ANNEALING. Theoretical studies of isochronal or "pulse" annealing were stimulated by the excellent experimental work of R. R. Coltman, C. E. Klabunde, and co-workers. The ultimate goal is the explanation of annealing peaks observed during warm-up after low-temperature recoil damage of cadmium in terms of activation energies, orders of kinetics, and basis defect processes. ELECTRON CROSS SECTIONS FOR ATOMIC DISPLACEMENTS. The Mott scattering series was used to numerically calculate atomic displacement cross sections by fast electrons for 18 elements selected to span the atomic table. Several atomic displacement thresholds were used, together with electron energies ranging up to 10 Mev. FORMAL SOLUTION OF SOME EQUATIONS OF RADIATION-ENHANCED DIFFUSION. Some analytical aspects of a set of equations pertinent to radiation-enhanced diffusion are discussed. (auth)

999 (ORNL-3676(p.27-31)) X-RAY DIFFRACTION. (Oak Ridge National Lab., Tenn.).

The (222) peak width of a nearly perfect copper crystal in the Bragg geometry was found to be uninfluenced by fast-neutron irradiation to 10^{19} n/cm^2, but absolute intensity measurements of x rays "anomalously" diffracted through thick copper crystals are affected by this dose. Preliminary results of experiments with defect images in Borrmann beam x-ray topographs of nearly perfect copper crystals are summarized. Abstracts of published papers on transmutation effects in crystalline solids (NSA 18: 17909) and x-ray "anomalous" diffraction by thick copper crystals are given. (R.E.U.)

1000 (ORNL-3676(p.35-9)) SPIN RESONANCE. (Oak Ridge National Lab., Tenn.).

A paramagnetic defect of irradiated quartz was found, which is an S = 1 state, stable at room temperature, and is probably a different electronic state of the E_1' atom. Abstracts are given of papers published or to be published in journals on the relation between E_1' centers and hydroxyl bonds in silica, paramagnetic resonance spectra of ytterbium and europium ions in thorium oxide, and hydrogen centers in irradiated quartz. An abstract of ORNL-3625, on paramagnetic centers in irradiated GeO_2 glass, is also included. (R.E.U.)

1001 (ORNL-3676(p.61-5)) LOW-TEMPERATURE IRRADIATION STUDIES. R. R. Coltman, J. K. Redman, C. E. Klabunde, and G. F. Fielder (Oak Ridge National Lab., Tenn.).

LOW-TEMPERATURE THERMAL-NEUTRON IRRADIATION FACILITY. The new low-temperature irradiation facility located at the BSR is completed and is operating routinely. The development of modifications to improve the reliability and capability of the system is under way. THERMAL-NEUTRON DAMAGE IN CADMIUM. By use of a new temperature-measuring technique, completed detailed isochronal recovery of (n,γ) damage in Cd is studied as a function of initial damage concentration. (auth)

1002 (ORNL-3676(p.66-73)) ELASTICITY AND ANELASTICITY STUDIES. (Oak Ridge National Lab., Tenn.).

The Bordoni imernal friction relaxation peak in deformed copper was found to be reduced considerably in height by fast-neutron irradiation, presumably through pinning of dislocations by radiation defects. Annealing at 400°C, which is known to eliminate defect pinning points, restored the peak to its original height. It is concluded that point defects play no role in the relaxation process. DOSE DEPENDENCE OF THE DISLOCATION BREAK-AWAY STRESS IN FAST-NEUTRON-IRRADIATED COPPER AS MEASURED BY AMPLITUDE-DEPENDENT INTERNAL FRICTION. Abstract of paper submitted for journal publication. APPARATUS FOR ANELASTICITY MEASUREMENTS USING FLEXURAL VIBRATION. An anelasticity apparatus was developed for which the sample can be a copper crystal oriented for etch pit observations of dislocation distribution. The sample is vibrated in flexure and its size is such that it can be made with existing equipment for producing crystals of very low dislocation density. EFFECT OF ANELASTICITY ON ULTRASONIC SECOND-HARMONIC GENERATION IN COPPER. In attempts to obtain third-order elastic constants of crystals by measuring distortion generated in high-amplitude sound waves, difficulties may occur if the attenuation is too high. It is shown that in the case of pure copper, where the dislocation attenuation is appreciable, the anticipated improve-

ment in observation of the second harmonic can be obtained by irradiating so as to pin the dislocations. CAPACITANCE MICROPHONE DETECTOR FOR ULTRASONIC WAVES. A highly sensitive, broad-band capacitance microphone detector was built so as to make possible absolute measurements of displacement amplitude and harmonic distortion in ultrasonic waves in crystals. (auth)

1003 (ORNL-3676(p.112-21)) SEMICONDUCTOR STUDIES. (Oak Ridge National Lab., Tenn.).

NATURE AND YIELD OF PHOTON- AND NEUTRON-INDUCED DEFECTS IN SEMICONDUCTORS. The radiation response of germanium and silicon to fast neutrons over a wide range of energy was determined for both monoenergetic neutrons and neutrons of known spectral distribution. Germanium is much more sensitive to the effect of disordered regions than is silicon, as is expected from differences in band structure of these two materials. ANNEALING OF ^{60}Co GAMMA-IRRADIATED GERMANIUM. The studies of the annealing properties of ^{60}Co gamma-irradiated germanium were continued, using a broader range of impurity concentrations and two different impurity types. The isochronal anneals show two annealing stages: a low-temperature stage between 289 and 380°K, and a high-temperature stage between 390 and 450°K. RADIATION EFFECTS AND THEIR ANNEALING IN ^{60}Co GAMMA-IRRADIATED ANTIMONY-DOPED GERMANIUM. Abstract of paper for journal publication. RADIATION EFFECTS IN CdS AND CdTe. CdS and CdTe were irradiated with ^{60}Co gamma rays, ^{137}Cs gamma rays, and thermal neutrons. Observed and theoretical damage rates are compared. (auth)

1004 (ORNL-3676(p.125-56)) RADIATION METALLURGY. (Oak Ridge National Lab., Tenn.).

KINETICS OF RADIATION-ENHANCED DIFFUSION IN Cu–Al. The relative kinetics of the resistivity change of first and second runs for Cu–15 at. % Al were analyzed. The kinetics of the resistivity change for an interrupted irradiation were also treated. The results suggest that interstitials, rather than vacancies, are responsible for enhancement of diffusion in this alloy. EFFECT OF DEFORMATION UPON NEUTRON RADIATION-ENHANCED DIFFUSION IN Cu–Al. The effect of prior cold working to 0 to 54% reduction in area on the rate of short-range ordering during irradiation at 100°C was determined for Cu–15 at. % Al. The decrease in ordering rate with increasing amounts of cold work is interpreted in terms of the introduction of sinks for radiation-produced point defects. ANNEALING OF Cu–Ni ALLOYS FOLLOWING NEUTRON IRRADIATION, QUENCHING, AND DEFORMATION. The isochronal annealing of Cu–Ni alloys containing 25 to 65 wt % Cu was studied following neutron irradiation at –180°C. The largest decrease in resistivity, indicative of radiation-enhanced segregation, was observed for Ni–40 wt % Cu. The isochronal annealing of this alloy was also investigated following quenching from 600 to 1050°C and deformation at below –100°C. RESISTIVITY MEASUREMENTS IN Fe–Si. Preliminary measurements are described of the resistivity of Fe–3.7 wt % Si as a function of temperature from –196 to 1050°C, and of the change in resistivity upon quenching from temperatures up to 850°C. IN-REACTOR INTERNAL FRICTION MEASUREMENTS OF INTERSTITIAL REARRANGEMENTS IN bcc METALS. In-reactor measurements of low-frequency internal friction were used to study the radiation-accelerated loss of nitrogen from solid solution in quenched Fe–0.015 wt % N alloys. No evidence for the re-solution of precipitates was observed upon irradiating aged samples. Measurements of internal friction during irradiation were also made for vanadium containing nitrogen and oxygen. FISSION-SPECTRUM IRRADIATION FACILITY FOR THE BSR. The preliminary design of a facility for the BSR is described that will provide a flux of neutrons whose energy distribution conforms closely to a fission spectrum. For a total flux of about 10^{12} neutrons cm^{-2} sec^{-1}, the heat load is about 15 kw. PLASTIC DEFORMATION OF IRON AND ITS ALLOYS. Plans are discussed to use etch pitting, electron transmission microscopy, and tensile tests at various temperatures and strain rates to study the plastic deformation of unirradiated and irradiated iron and its alloys. CRYSTALLOGRAPHY OF DISLOCATIONS AND DISLOCATION LOOPS IN DEFORMED IRON. Abstract of paper for journal publication. IRRADIATION EFFECTS ON THE MECHANICAL PROPERTIES OF IRON AND IRON ALLOYS. An irradiation of tensile samples of iron and steel is described, which is part of a program to study the effect of dose, dose rate, and irradiation temperature on properties. REACTOR PRESSURE-VESSEL MATERIALS. Abstract of paper for journal publication. EGCR PRESSURE-VESSEL SURVEILLANCE PROGRAM. The EGCR pressure-vessel surveillance program is described, and the results are given of pre-irradiation characterization tests on impact and tensile samples of EGCR steel. SM-1 PRESSURE-VESSEL SURVEILLANCE PROGRAM. A study is described of the fracture appearance of the cross section of fractured irradiated and control impact samples from the pressure-vessel surveillance program for the SM-1 reactor. ACCELERATED IRRADIATIONS OF PRESSURE-VESSEL STEELS. Impact samples of pressure-vessel steel characteristic of weld heat-affected zones were irradiated at elevated temperatures in the ORR. In two experiments, the anticipated irradiation temperature of 550°F was exceeded. CHARPY IMPACT MACHINE CALIBRATION. The status of attempts to calibrate the impact machines in accordance with the specifications of two standards agencies is discussed. (auth)

1005 (ORNL-P-556) THE EFFECT OF IRRADIATION ON PRECIPITATION OF NITRIDES IN IRON. J. T. Stanley (Oak Ridge National Lab., Tenn.). July 1964. Contract W-7405-eng-26. 17p. (CONF-711-3). Dep.(mn); $1.00(cy), 1(mn) OTS.

From Symposium on Body-Centered Cubic Materials, Gatlinburg, Tenn., Aug. 1964.

Internal friction measurements were used to study the effect of irradiation on the precipitation of nitrogen from solid solution in α–Fe. Although irradiation does not change the jump rate of nitrogen in α–Fe, the rate of precipitation is attributed to the formation of nucleation sites during the irradiation. The enhancement effect saturates after a fast neutron dose of 3×10^{15} neutrons/cm^2. Bombardment with 2 Mev electrons to a dose of 1.8×10^{16} electrons/cm^2 did not produce any enhanced nucleation. At the present time it is believed that the radiation-produced nucleation sites are vacancy of interstitial clusters. (auth)

1006 (PDL-46195) EFFECTS OF VAN ALLEN RADIATION BELTS ON ELECTRONIC MATERIALS. An Introductory Bibliography. PDC Search No. 63-003. Richard W. H. Lee, comp. (National Research Council. Prevention of Deterioration Center). Jan. 18, 1963. 7p. (AD-601298). $1.10(OTS).

A bibliography of 32 references is presented on the effects of space radiation on electronic materials. (D.L.C.)

1007 (RISÕ-83) CLASSICAL SCATTERING CROSS SECTIONS FOR RADIATION-DAMAGE CALCULATIONS. I. CUT-OFF POTENTIALS. P. Sigmund and P. Vajda (Denmark. Atomenergikommissionen. Forsøgsinstitut, Risø). May 1964. 27p. Dep.(mn); Jul. Gjellerup, 87, Sölvgade, Copenhagen K, Denmark.

Classical scattering cross sections are calculated for the Thomas-Fermi interatomic potential by means of the method of matching potentials by Leibfried and Oen. The agreement with results by Lindhard, et al., is good for intermediate energy transfers. The purpose of the work was to obtain various cross sections applicable for the solution of those integral equations governing radiation damage in solids that require detailed knowledge of the collision spectrum. The cut-off radius of the matching potential turns out to become extremely small at energies $\gg$1 kev. It is concluded that forward scattering is underestimated by the matching method for high energies. Therefore three methods of cutting the potential V(r) off at a fixed radius determined by lattice geometry are discussed. (auth)

1008 (JPRS-26808(p.157-68)) INVESTIGATION OF THE KINETICS OF THE OXIDATION OF IRRADIATED REACTOR GRAPHITE IN AN IRRADIATED AND NON-IRRADIATED MEDIUM OF NITROGEN AND MIXTURE OF NITROGEN WITH WATER VAPOR. N. T. Belinskaya and L. G. Pen'kova. Translated from p.185-98 of "10 Let Pervoy v Mire Atomnoy Elektrostantsii SSR."

The kinetics of the oxidation of irradiated reactor graphite with irradiated and non-irradiated vapor-gas mixtures of $H_2O + N_2$ at concentrations of water vapor of 5 to 100% and with nitrogen at 700–1150°C were examined. (C.E.S.)

1009 EXPERIMENTAL INVESTIGATIONS IN THE INSTITUTE FOR REACTOR MATERIALS. H. Wollenberger, H. J. Stoecker, and K. Luecke (Kernforschungsanlage, Julich, Ger.). Atompraxis, 10: 412-15(Sept.-Oct. 1964). (In German)

A brief review is given of the principal areas of experimental investigation at the Institute. These include investigations on the mechanism of radiation damage in pure metals and alloys, the effect of radiation on ferromagnetic properties, and correlation of lattice faults in unirradiated samples. The constitution and properties of ceramic fuel elements and other reactor construction materials were also studied. (tr-auth)

1010 THEORETICAL SOLID-STATE PHYSICS AT THE INSTITUTE FOR REACTOR MATERIALS. W. Ludwig (Kernforschungsanlage, Julich, Ger. and Technische Hochschule, Aachen). Atompraxis, 10: 415-19(Sept.-Oct. 1964). (In German)

A brief review is given of the work carried out at the Institute. The greatest part of the studies are on crystals with vacancies, and comprise the theory of radiation damage, magnetic problems, decompositions and plasticity, dynamics of crystals with vacancies, the conductivity of metals. Some problems on ideal crystals (anharmonicity and molecular crystal dynamics) were also studied. (tr-auth)

1011 γ-RAY INDUCED FORMATION OF COLOR CENTERS IN PLASTICALLY DEFORMED POTASSIUM CHLORIDE CRYSTALS. J. Z. Damm (Inst. of Structural Research, Wroclaw, Poland). Bull. Acad. Polon. Sci., Ser. Sci. Chim., 12: 413-17(1964).

The deformation-induced generation of cation and anion vacancies in gamma irradiated potassium chloride crystals is discussed on the basis of changes observed in the F, M, and V bands. During short irradiation periods, in the formation of F centers the anion vacancies present before deformation are engaged plus some further amounts generated by plastic deformation. For higher irradiation doses additional vacancies are formed as the effect of irradiation. As the plastic deformation should produce in the crystal both anion and cation vacancies, the deformation effect on the V band growth was also examined. It was found that the contribution of V_3 band decreases with deformation. Simultaneously, a growth of a band lying at 230–240 mm, corresponding to the V_2 band is observed. The growth in this band should reflect the deformation-induced generation of cation vacancies. In contrast with the nondeformed crystals in which M centers appear, after the inflection point in the F band growth curve has been reached, the deformed samples show the growth of the M band from the very beginning of irradiation. (P.C.H.)

1012 FORMATION AT LOW TEMPERATURE OF DEFECTS IN N SILICON BOMBARDED BY γ RAYS. Jean Messier and Jorge Merlo Florès (Centre d'Etudes Nucleaires, Saclay, France and Comision Nacional de Energia Atomica, Argentina). Compt. Rend., 259: 1074-7 (Aug. 3, 1964). (In French)

The conditions for the low-temperature formation of a level at 160 Mev in the conduction band were studied by measurement of the Hall effect and resistivity in high-resistivity N silicon. The rate of introduction of this level as a function of the bombardment temperature and its formation velocity at low temperature differentiates sharply the vacancy–oxygen associations observed by nuclear resonance. (tr-auth)

1013 EVALUATION BY EXCITON SPECTROSCOPY OF THE DIMENSIONS OF GROUPS OF DEFECTS PRODUCED IN A CRYSTAL BY BOMBARDMENT WITH NEUTRONS OR BY HEATING. Kong-Sop Song, Serge Nikitine, Jean-Bernard Grun, and Michel Grosmann (Universitât, Strasbourg). Compt. Rend., 259: 1087-90(Aug. 3, 1964). (In French)

The perturbation of a crystal either by an electric field or by neutron bombardment or annealing causes the appearance, in crystals with several components (e.g., Cu_2O or CuCl), of fine structure rays along with regular exciton rays. The displacement of these rays in the case of neutron bombardment or annealing with respect to the case of electric field perturbation makes possible the evaluation of the dimensions of perturbations produced by neutron bombardment or annealing. (tr-auth)

1014 EFFECTS OF FAST NEUTRONS ON THERMAL CONDUCTIVITY OF GERMANIUM MEASURED AT LOW TEMPERATURE. Nguyen Van Dong (Centre d'Etudes Nucleaires, Saclay, France). Compt. Rend., 259: 1091-4 (Aug. 3, 1964). (In French)

The thermal conductivity of germanium was measured between 16 and 100°K before and after irradiation by fission neutrons. It was shown that the decrease of the thermal conductivity in the temperature region studied was principally a result of faults of large dimensions. (tr-auth)

1015 PHASE TRANSFORMATION AND DISORDERING BY IRRADIATION OF THE COMPOUND U_2Ti. Jacqueline Bloch (Commissariat a l'Energie Atomique, [Paris]). Compt. Rend. 259: 1343-6(Aug. 10, 1964). (In French)

It was established that the intermetallic compound U_2Ti with ordered hexagonal crystalline structure undergoes, under the effect of fission-particle irradiation, a disordering accompanied by a phase change. The high temperature disordered phase was obtained. This transformation is achieved after 8×10^{16} fissions/sec. Anneal restoration was studied and it was established that the restoration occurs continuously. (tr-auth)

1016 RADIATION SOURCES FOR RADIATION VULCANIZATION AND IRRADIATION OF ELASTOMERS. F. A. Makhlis and A. Kh. Breger. Kauchuk i Rezina, No. 8, 18-23(1964).

Problems in the irradiation of elastomers and the construction of high-performance semi-industrial equipment for radiation vulcanization using ^{60}Co and accelerated electrons and neutrons are discussed. Comparative data on the use of thermal neutrons and fission neutrons for the irradiation of rubber, elastomer and resin show that the greatest yield is obtained with fast neutrons, except for the elastomer, which does not contain hydrogen. Data on the absorption of radiation from the widely used emitters, such as ^{60}Co and ^{137}Cs, in rubber, resin, aluminum, iron, and lead show that the absorbed energies are constant within ±10% for 20-cm-thick samples of rubbers with unit density, and for 10-cm-thick samples of heavier rubber. With accelerated neutrons at an energy of 1 Mev, the depth of maximum ionization is 1.5 mm for rubber 0.87 mm for elastomer, and 0.77 mm for resin. Plots of efficiency against sample thickness showed that the optimum thickness for irradiation with accelerated electrons is attained when 80–90% of the energy of the incident ray is used. It can be increased by bilateral irradiation. Radiation vulcanization requires sufficiently powerful radiation emitters to ensure the necessary dose of 1-50 Mrads. Various aspects of the economical use of radiation vulcanization in industry are discussed. On irradiating silicone rubbers with accelerated electrons at temperatures of 40, 145, and 200°C, the number of cross links formed over a dosage range of 0.1–0.2 MR was twice as high at 200 as at 40°C at the same dose. The tensile strength was also higher at 200°C. After irradiation by ^{60}Co at a dose of 5-10 Mrads, preheated carboxyl rubbers vulcanized with metal oxides had a higher thermomechanical stability and strength. The cost of radiation vulcanization can be

reduced by using the heat generated in the nuclear reactor, in which the radiation apparatus operates. (OTS)

1017 PHOSPHORESCENCE OF DIMETHYLANILINE WITH $FeCl_3$ SCAVENGER IRRADIATED AT LOW TEMPERATURES. Istvan Kosa Somogyi and Maria Vizesy. Magy. Tud. Akad. Kozp. Fiz. Kut. Int. Kozlemen., 12: 287-97(1964). (In Hungarian)

The phosphorescence excited thermally and by irradiation in dimethylaniline containing $FeCl_3$ scavenger and irradiated at −196°C with ^{60}Co gamma source is studied. It is inferred from the spectral distribution of the emitted light and from the values of the exciting energies that the phosphorescence and the energy transfer can be explained by the motion of the excitons involved in the triplet state and their reactions with the solute. (auth)

1018 OPTICAL ROTATION OF QUARTZ AFTER NEUTRON, γ-, AND ELECTRON IRRADIATION. H. Buchholz (Hahn-Meitner-Institut fur Kernforschung, Berlin). Naturwissenschaften, 51: 432-3(1964). (In German)

The decrease of the rotation angle was measured as a function of the integral neutron dose in the irradiation of different quartz varieties with fast neutrons and with electrons at 1.5 Mev. In both cases there was a sharp initial decrease of the curve followed by a constant lower decrease at higher doses. The form of the curve indicates the presence of two processes in the optical rotation. Gamma irradiation of different quartz varieties confirmed a direct relation between the saturation of the A band and the dose-independent process in the optical rotation. (J.S.R.)

1019 IRRADIATION OF URANIUM BY ELECTRONS AT VERY LOW TEMPERATURE. J. C. Jousset (Centre d'Etudes Nucleares, Fontenay-aux-Roses, France), A. Lucasson, and P. Lucasson. Phys. Letters, 12: 295(Oct. 15, 1964). (In French)

Samples of αU are irradiated by 1.7-Mev electrons at 12°K. The resistance ratios of the two samples used are R(2/0°C)/R(4.2°K) = 74 and 85. An exposure of 3.5×10^{17} electrons/cm^2 produces an increase of electric resistivity of 5×10^{-6} μ ohm · cm. During isochronous annealing of the irradiated samples, about 60% of the induced resistivity disappears in a step near 20°K. Another 20% of the induced resistivity disappears between 20 and 100°K. (T.F.H.)

1020 THE KINCHIN-PEASE RADIATION DAMAGE CALCULATION FOR INVERSE POWER INTERATOMIC POTENTIALS. R. P. W. Lawson and G. Carter. Phys. Letters, 12: 296-7(Oct. 15, 1964).

The Frenkel-pair density produced by irradiation of a solid is calculated, assuming a model for the details of the atomic displacement process and an inverse-power interatomic potential. The validity of the calculation near and far above threshold is discussed. (T.F.H.)

1021 THE EFFECT OF NUCLEAR RADIATIONS ON VARIOUS MATERIALS. Cezary Pawlowski (Technical Univ., Warsaw). Postepy Fiz., 15: 323-39(1964). (In Polish)

The various methods used for determining the effects of radiations on matter are reviewed. Microscopic methods are suitable for examining the effects of strongly ionizing radiation on thin layers of the material. Microphotographic and x-ray diffraction methods may be used for studying the effects of a radiation; ions generated by small amounts of Rn can be detected in mixtures of gases by means of a modified Wilson chamber. The findings made in gases can be extended to liquids and solid materials. The thermal theory of local dislocations in crystals is reviewed. The conclusions drawn from the bubble formation in transformer oil subjected to α radiation are closely examined; the findings are considered together with observations of irradiated nitrocellulose, in which gas bubbles, acicular crystals and hexagonal crystals are formed. On the other hand, in cellophane the grain formation is enhanced by radiation, while in paraffin, recrystallization is induced. Exposure to ionizing radiation resulted in the deformation and discoloration of mica and in the change of the texture, similar to the one resulting from mechanical deformation, in Cd foil. The experimental results in the above cases and in the case of phosphors are explained in the light of the current theories. (TTT)

1022 WEAR RESISTANCE OF IRRADIATED NYLON AND POLYETHYLENE. Masashiro Torii. Radioisotopes (Tokyo), 13: 320-2(July 1964). (In Japanese)

Nylon 66 (Zytel), Nylon 6 (Griron), and polyethylene (Hyzex) were irradiated with 10-100 Mrad of Van de Graaff beta beams or cobalt-60γ beams at dose rates of 2.5×10^7 Rad/min and 1.6×10^5 R/hr, respectively and/or subjected to heat treatment in attempts to improve wear resistance. Nylon materials were heat treated in machine oil at 180°C and polyethylene in hot water. Heat treatment following irradiation was started several hours after termination of irradiation. Barcol hardness of all treated materials increased with dose and duration of heat treatment. Density showed little change with dose but increased with heat treatment. Irradiation increased melting points of nylons very slightly, but polyethylene showed substantial increase particularly following beta dose. Wear of nylons generally increased with dose with γ irradiation bringing about more pronounced effects. Heat treatment of at least 30 minutes increased wear resistance of both irradiated and non-irradiated materials. The coefficient of friction of nylons showed slight decrease with dose. Heat treatment increased coefficient of friction of Nylon 6 and increased that of Nylon 66 given low radiation exposure. Limiting bearing pressure of Nylon 6 was unaffected by dose or heat treatment while that of Nylon 66 was slightly increased. Limiting bearing pressure of polyethylene decreased with dose particularly that of material exposed to beta beam. No increase in this value was brought about by heat treatment. (TTT)

1023 EFFECT OF NEUTRON-INDUCED DEFECTS ON THE CURRENT-CARRYING BEHAVIOR OF NIOBIUM STANNIDE. G. W. Cullen, R. L. Novak, and J. P. McEvoy. RCA Rev., 25: 479-90(Sept. 1964).

The current-carrying characteristics of niobium-stannide cylindrical and strip deposits on ceramic substrates have been measured before and after exposure to fast neutron fluxes. Changes in the flux shielding properties of cylindrical samples demonstrated qualitatively that the α of the samples is increased by neutron irradiation. More quantitative measurements were possible on the strip samples, where the current was supplied externally. On one strip, α more than doubled after exposure to a flux of 6.9×10^{17} neutron/cm^2. The increase in the critical currents subsequent to irradiation is associated with the action of defects, introduced by the neutron damage, which pin fluxoids and thus stabilize the applied currents. (auth)

1024 ALTERATION OF THE STRUCTURAL-MECHANICAL PROPERTIES OF GELATIN UNDER THE ACTION OF IONIZING RADIATION. E. M. Nanobashvili and I. G. Bakhtadze. Soobshch. Akad. Nauk Gruz. SSR, 34: No. 1, 79-84(1964).

Aqueous 1-5% solutions of gelatin were subjected to X or ^{60}Co gamma irradiation at temperatures within a 20−30°C range. Determinations of ultimate shearing stress were conducted and a relationship was established between the radiation dose, temperature, and P_M value (dynes/cm^2). It was found that in a 1% gelatin solution the absorption of 2.46 ev/ml · 10^{18} units of energy at 20°C raised the P_M value from an original 200 to over 830 dynes/cm^2, resulting in gelation. It was observed that irradiation with higher doses of x-rays or gamma rays and the irradiation of higher concentrations of gelatin caused an increased gelation. Higher temperatures had a detrimental effect on the P_M of irradiated gelatin solutions, and at 27°C the ultimate shearing stress decreased to below its original value due to a structural breakdown of the gelatin. The theoretical aspects of gelation under the impact of ionizing irradiation are discussed. (OTS)

1025 URANIUM−MOLYBDENUM ALLOYS USEFUL AS NUCLEAR FUELS. A. J. Lehmann and J. Decours (Centre d'Etudes Nucleaires, Saclay, France). Z. Metallk., 55: 548-52(Sept. 1964). (In French)

The behavior of uranium with up to 2 wt % Mo was tested after various heat treatments and reactor radiation. The results are reported. (tr-auth)

1026 ACTIONS CHIMIQUES ET BIOLOGIQUES DES RADIATIONS. SEPTIEME SERIES. (Chemical and Biological Actions of Radiations. Seventh Series). M. Haissinsky, ed. Paris, Masson et Cie Editeurs, 1964. 294p. 92 F.

Four papers prepared for the Seventh Series review the most recent and significant results, both experimental and theoretical, on the effects of radiation on metals, semiconductors, and crystals. The subjects are radiation effects on metals and alloys, radiation effects on semiconductors, radioinduced defects in crystalline alkali halides, and characteristic energy losses of electrons in solids. Separate abstracts were prepared for 3 papers. One section on semiconductors was previously abstracted in NSA as 18: 30276. (J.S.R.)

For abstracts of individual sections see: 1027, 1028, and 1029.

1027 RADIATION EFFECTS ON METALS AND THEIR ALLOYS. Y. Quéré (CEN, Fontenay-aux-Roses, France). p.1-116 of "Actions Chimiques et Biologiques des Radiations. Septieme Series." Paris, Masson et Cie Editeurs, 1964. (In French)

Elementary data on the types of faults in metals and alloys are introduced briefly. After a survey of the characteristics of elastic collisions, it is shown how an incident particle creates faults in a metallic lattice and under what conditions these collisions are propagated along the lattice itself. Some typical experiments on the effects of radiations in pure metals, alloys, and fissionable metals are reviewed. A secondary effect of the irradiation of metals, the collection in bubbles of gaseous atoms introduced by bombardment in the lattice, is discussed. (J.S.R.)

1028 THE PRODUCTION OF DEFECTS IN CRYSTALLINE ALKALI HALIDES BY IONIZING RADIATION. D. A. Wiegand (Carnegie Inst. of Tech., Pittsburgh) and R. Smoluchowski. p.165-256 of "Actions Chimiques et Biologiques des Radiations. Septieme Series." Paris, Masson et Cie Editeurs, 1964.

The description of the nature of defects is followed by a summary of the essential aspects of the absorption processes of both corpuscular and electromagnetic radiation. The mechanisms of defect formation in perfect and imperfect lattices are discussed. A review of experimental results that gives insight into the simpler defects introduced into alkali halide crystals by ionizing irradiation and that also enables some deductions to be made about the mechanisms by which these defects are introduced follows. 159 references. (J.S.R.)

1029 ENERGY LOSS CHARACTERISTICS OF ELECTRONS IN SOLIDS. L. Marton (Universite, Paris) and C. Marton. p.257-81 of "Actions Chimiques et Biologiques des Radiations. Septieme Series." Paris, Masson et Cie Editeurs, 1964. (In French)

The experimental observations and the theoretical interpretations on the energy transfer from a free electron to the electron system of atoms or molecules are reviewed. Dispersion phenomena and multiple losses are discussed. A correlation with the optical constants is considered. Transition radiation is briefly described. Second-order losses are also considered. (J.S.R.)

METEOROLOGY

Refer also to abstracts 709 and 720.

1030 (AECL-2051) CONTINUOUS RECORDING OF WAVE PATTERNS ON A BODY OF EXPOSED WATER. S. P. Newbery and A. S. Coveart (Atomic Energy of Canada Ltd., Chalk River, Ont.). Aug. 1964. 11p. Dep.; $0.50 (AECL).

An apparatus is described for chart recording of the small wave motions occurring on a wind-agitated water surface. The detector drives a battery-powered radio transmitter that is linked to a receiving station equipped with line-operated recording facilities. (auth)

1031 (CRL-86) SOME RECENT EXPERIMENTS ON TRANSFER OF RADIOACTIVE TRACERS FROM AIR TO NATURAL SURFACES. P. J. Barry (Atomic Energy of Canada Ltd., Chalk River, Ont.). May 14, 1964. 18p. (AECL-2045). Dep.; $0.50(AECL).

Field experiments to measure the rate of deposition of titrated water vapor and radioiodine vapor to natural snow surfaces are described. The meteorological applications of the results obtained in the field of gaseous exchange between atmosphere and the earth's surface such as for example in evaporation and evapo-transpiration are discussed. By simultaneously measuring the rates of deposition of two radioactive tracers having different molecular diffusivities it has been found that molecular diffusion plays an important role in addition to turbulent eddy diffusion, presumably because of the presence of a laminar sublayer in close proximity to the surface. By comparing the relative transfer rates for the two tracers it is possible to estimate the thickness of the laminar sublayer. (auth)

1032 (HNS-55) METEOROLOGICAL INFLUENCES UPON Sr^{90} FALLOUT CONCENTRATION IN PRECIPITATION. PART 2. CONVECTIVE ACTIVITY AND EXTRATROPICAL CYCLONES. Paul Kruger, Charles L. Hosler, and Albert Miller (Hazleton-Nuclear Science Corp., Palo Alto, Calif.). [1964]. Contract AT(04-3)-459. 31p. (CONF-765-2). Dep.(mn); $2.00(cy), 1(mn) OTS.

From 2nd Conference on Radioactive Fallout from Nuclear Weapons Tests, Germantown, Md., Nov. 1964.

Studies were made of ^{90}Sr concentration in precipitation from extratropical cyclones (Central Penn. and West Coast of U. S.) and showers and thunderstorms (Okla. and Central Penn.). In the convective showers, the peak ^{90}Sr concentration was compared to the average concentration. In the extratropical cyclones, evaporation, precipitation growth mechanism, and nuclear debris deposition were studied. (D.L.C.)

1033 (HW-81746(p.1.1-19)) PREDICTION OF ENVIRONMENTAL EXPOSURES FROM SOURCES NEAR THE GROUND, BASED ON HANFORD EXPERIMENTAL DATA. J. J. Fuquay, C. L. Simpson, and W. T. Hinds (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). (HW-SA-3229)

Values of peak exposure and standard deviations of exposure distributions downwind from a continuous point source are presented for 46 Hanford ground source diffusion experiments. Exposure data were found to order in terms of atmospheric stability when plotted as a function of the travel time. The crosswind variances of the exposure distributions are expressed in terms of the travel time and the product of the standard deviation of the wind direction distribution and the mean wind speed $\sigma_\theta \bar{u}$, in an equation resulting from G. I. Taylor's work in 1921. Prediction methods developed from these concepts permitted extrapolation of the results obtained from short releases to much longer release periods. Good agreement between predicted and observed exposure distributions was obtained from these models, using independent data. (auth)

1034 (HW-81746(p.1.29-36)) DISPERSION FROM ELEVATED SOURCES. C. E. Elderkin, W. T. Hinds, and N. E. Nutley (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Surface measurements of the atmospheric diffusion from continuous point source releases at 56.4 m were continued at Hanford with 14 tests performed during 1963. Analyses of eight earlier tests compared well with results anticipated from a bivariate normal model, but consistent deviations from the model were noted. (auth)

1035 (HW-81746(p.1.36-43)) PRECIPITATION SCAVENGING PROCESSES. R. J. Engelmann (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Rain scavenging efficiencies measured using zinc sulfide particles are presented. These were compatible with the air flow patterns thought to exist about raindrops. The efficiencies were combined with Hanford raindrop spectra to yield washout coefficients in light rains. (auth)

1036 (HW-81746(p.1.43-52)) ATMOSPHERIC TRACER TECHNOLOGY. P. W. Nickola and M. F. Scoggins (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

The Rankin technique for assay of bulk field samples of airborne fluorescent tracer continued to yield good results. Recent recounts were in good agreement with counts made in 1959. The possibility of replacing water with trichloroethane as the carrier for particulate tracers during generation is considered promising. Larger tracer emission rates would be possible. Tests disclosed that the effects of extreme heat and of solar radiation on one fluorescent tracer (2210) were negligible. Field models of the zinc sulfide real-time sampler disclosed an improvement of approximately four in sensitivity over the prototype model. Results from two field experiments involving tracers other than the standard 2210 are presented. (auth)

1037 (HW-81746(p.3.58-68)) INVESTIGATION OF THE NATURE OF I^{131} IN THE ATMOSPHERE. J. D. Ludwick (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

The physical and chemical forms of iodine were investigated through air and vegetation sampling downwind from three ^{131}I radioisotope releases. Mass sampling was conducted when iodine was dispersed during two separate tests having controlled emissions. Air sampling was also conducted subsequent to a Purex release. Significant changes in the form of iodine were noted over the distance sampled. The iodine released from the controlled tests did not indicate chemical or physical adsorption similarity with that from Purex. (auth)

1038 (HW-81746(p.3.68-76)) DUAL TRACERS UTILIZING THE FLUORESCENCE OF FLUORESCEIN AND CALCIUM ACETYLSALICYLATE. J. D. Ludwick (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

A procedure was developed for the detection of fluorescent materials in a study of their possible use as atmospheric tracers. Instrumentation, which allowed differentiation of excitation and emission spectra, was used. This resulted in an analytical method for simultaneous analysis of the fluorescent materials, fluorescein, and the calcium salt of aspirin. Cross-tracer interference was reduced to a minimum and as little as 5×10^{-11} g of fluorescein and 3×10^{-9} g of Ca-aspirin was measured. (auth)

1039 (HW-81746(p.4.63-6)) SUBISOKINETIC SAMPLING OF PARTICLES IN AN AIR STREAM. G. A. Sehmel (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

The errors associated with sampling at filter face velocities much below the carrying stream velocity (subisokinetic) were studied. Data were obtained for several subisokinetic flow rates for wind speeds between 2.7 and 9 miles/hr. Zinc sulfide particles in the range of 2 to

25 μ were used. For the collector geometry used and the flow conditions imposed, a 10-μ diameter particle would appear to be present at a concentration as high as 2.4 times the actual concentration. Corrections for various diameter particles, sampling velocities, and relative subisokinetic rates are presented. (auth)

1040 (HW-81746(p.5.1-5)) DETECTION OF AIR CONCENTRATIONS OF FLUORESCENT MATERIAL FOR ATMOSPHERIC PHYSICS STUDIES. M. O. Rankin and E. M. Sheen (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Atmospheric physics field diffusion experiments require measurement of airborne particulate concentrations. An instrument was developed to monitor a scintillating tracer material on a real time basis, and three monitors were assembled for use in the experiments. The data obtained will provide information about the time history of such airborne concentrations that contribute to the mean concentration. The instrument includes a sampler probe where the particles (2210 fluorescent pigment) are exposed to ultraviolet light, a viewing chamber where a phototube is used to detect the phosphorescent particles, and a recorder. The minimum detectable air concentration was determined, through a series of experiments, to be 4×10^{-7} g/m^3. (auth)

1041 (HW-81746(p.5.6-10)) AUTOMATIC DATA SYSTEM FOR ATMOSPHERIC PHYSICS STUDIES. E. M. Sheen and O. A. Ratcliffe (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

An automatic data collection and recording system was developed for use in atmospheric physics micrometeorological studies regarding air diffusion and particulate transport. Wind speed, wind direction, and temperature data are collected from six stations mounted on an 80-ft portable field tower. A 5-sec collection time interval is employed, since this permits short-term analysis and recording of the variables. The collected information is digitized and printed and is also presented on punched paper tape for use in computer reduction. Except for minor difficulties with a commercial digital voltmeter used in the system, general field tests, conducted over a period of several months, indicated that satisfactory operation could be achieved. (auth)

1042 (HW-81746(p.5.10-16)) RADIOTELEMETERING SYSTEM IMPROVEMENTS. C. A. Ratcliffe and E. M. Sheen (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

To achieve improved operational capabilities and reliability, considerable circuitry development was undertaken on the Meteorological Radiotelemetry System. A thorough system study was conducted and specific circuits were then developed to replace those of marginal capability. Major problems were noted with the remote data stations (19) and the resultant development activities were concentrated in this area. One data station was, in essence, redesigned to incorporate the desired improvements. Following initial testing of this field prototype, a second data station was similarly converted to provide comparative data. The basic improvements incorporated included elimination of vacuum tube circuits, elimination of most of the original relays and other moving parts, development of a three-range radiation monitoring portion, and incorporation of a simpler and more reliable wind direction measurement scheme. Preliminary testing of the field prototype data station showed satisfactory performance over a wide range of ambient conditions, and plans were established for thorough in-field testing of both modified data stations. The completed system is slated to provide wind speed, wind direction, and radiation level data from various Hanford locations. (auth)

1043 WASHING RADIOACTIVE DUST OUT OF THE ATMOSPHERE. K. P. Makhonko. Izv. Akad. Nauk SSSR, Ser. Geofiz., No. 4, 596-603(1964).

A semi-empirical formula defining the change with time of long-lived specific radioactivity in cumulus and stratus rain clouds is given. Variations are offered for the different types of clouds. It was concluded that the radioactivation of rain takes place chiefly in clouds. The washing-out process as a result of capture of dust particles by rain drops is of much less significance. When the numbers of nuclear tests were decreased and then stopped, radioactive fallout with rainfall declined, and in 1960 it became equal to dry fallout. This decline may be explained by exhaustion of extreme sizes of particles of radioactive dust as a result of the washing-out process. (OTS)

1044 RESULTS OF EXPERIMENTS ON ATMOSPHERIC DIFFUSION. R. Le Quinio and J. Hugon. 14p. (CONF-337-23). (In French)

From International Conference on Radioactive Pollution of Gaseous Media, Saclay, France, Nov. 1963.

Studies on atmospheric diffusion were made at six French sites, each having different characteristics, but none flat and homogeneous. Site and meteorological factors affecting the diffusion were determined. The results are briefly discussed. (J.S.R.)

PHYSICS

General

Refer also to abstract 1497.

1045 (AFCRL-64-184) THE ATMOSPHERIC PRESSURE WAVE GENERATED BY A NUCLEAR EXPLOSION. Scientific Report No. 1. David B. van Hulsteyn (Michigan. Univ., Ann Arbor). Feb. 1964. Contract AF19(628)-304. 51p. (AD-601385) $2.00 (OTS).

The problem of describing the pressure wave that an observer located on the ground will detect at a distance of a few thousand kilometers from a low altitude nuclear explosion is investigated. The result obtained entails the correlation of the theoretical values of the period and amplitude with those determined from microbarograph recordings. For the frequency spectrum considered, an isothermal atmospheric temperature model is sufficiently accurate and allows an analytic development of the Green's function. This Green's function makes it possible to express the frequency dependent pressure at an observer's position in terms of the pressure generated by a nuclear blast. It is convenient to treat this explosion by using a form of Huygen's principle, rather than a point source representation. This configuration permits the determination of the relationship between the energy of the explosion and the amplitude of the theoretical pressure pulse. The final step involves the performing of the inverse Fourier transform in order to determine the time variation of the pressure wave train. (auth)

1046 (ANL-6908) THE ANALYSIS OF COMPLEX GAMMA-RAY SPECTRA. William J. Snow (Argonne National Lab., Ill.). July 1964. Contract W-31-109-eng-38. 23p. Dep.; $1.00(cy), 1(mn) OTS.

An IBM-704 program has been written to increase the precision of the determination of the relative intensities and energies of gamma rays in a complex spectrum observed following neutron capture in neutron resonances. The quantity chi-square is formed for the complex spectrum in as many as ten resonances and minimized simultaneously with respect to all unknown intensities as well as the unknown gamma-ray energies. This simultaneous treatment makes use of the wide Porter-Thomas fluctuations in the intensities of the gamma ray to fix the gamma-ray energies. (auth)

1047 (FZK-186-2) NUCLEAR RADIATION HEATING IN LIQUID HYDROGEN. VOLUME II. EXPERIMENTAL DATA. W. A. Hehs, B. O. McCauley, G. E. Miller, and D. M. Wheeler (General Dynamics/Fort Worth. Div. of General Dynamics Corp., Fort Worth, Tex.). June 30, 1964. Contract NAS-3-3324. 607p. (NASA-CR-54078)

Experimental data are presented for the Boil-Off and Self-Pressurization Runs and for the Flow Runs in a study of reactor radiation heating of liquid hydrogen in a tank. The two reactor configurations were operated at power levels up to 5.7 Mw. (D.L.C.)

1048 (JAERI-6015) TABLES FOR CONVERSION OF NEUTRON DIFFRACTION ANGLES TO INTERPLANAR SPACING. Shigehiro Komura (Japan Atomic Energy Research Inst., Tokyo). July 1964. 111p. Dep.(mn).

The tables of interplanar spacing values $\underline{d}$ in angstrom units corresponding to the diffraction angles 2θ, in units of degree and minute are given for the wavelength of incident neutrons λ whose values are those usually used in neutron diffraction investigations; λ ranges from 1.0000 to 1.2000 angstrom in intervals of 0.0100 angstrom. (auth)

1049 (LAMS-2985) A NUMERICAL INTEGRATION OF A 97-KT EXPLOSION IN SEA LEVEL AIR. D. D. Eilers (Los Alamos Scientific Lab., N. Mex.). Oct. 1963. Contract W-7405-eng-36. 150p. Dep.(mn); $4.00(cy), 3(mn) OTS.

An extensive numerical integration was made for a 97 kt explosion in sea level air using detailed data for the equation of state and opacity for air. The results are offered in the form of graphs and tables and illustrate in detail the shock wave and fireball phenomena from zero time through approximately twice breakaway time. Comparisons are made with previous calculations done by Brode. (auth)

1050 (NP-14404) PROCEEDINGS OF THE SECOND ANNIVERSARY SYMPOSIUM, JANUARY 3 TO 9, 1964. Some Recent Trends in Theoretical Physics. Matscience Report 21. (Inst. of Mathematical Sciences, Madras). 340p. Dep.(mn).

Separate abstracts were prepared for 19 of the 20 papers included; the remaining paper reviews current trends in mathematical research. Subjects covered include symmetries, strong and electromagnetic interactions, weak interactions, and many-body problems. (R.E.U.)

For abstracts of individual papers see: 1409, 1410, 1411, 1412, 1413, 1414, 1415, 1416, 1417, 1418, 1419, 1420, 1421, 1422, 1423, 1424, 1425, 1558, and 1559.

1051 (NYO-2391-3) ROTATIONAL DEGREES OF FREEDOM OF LATTICE DEFECTS IN SOLIDS. Report No. 254. Venkatesh Narayanamurti (Cornell Univ., Ithaca, N. Y.). Sept. 14, 1964. Contract AT(30-1)-2391. 12p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The effects of substitutional impurities on the rotatory motion in molecules are discussed, and spectroscopic evidence for the types of motion predicted by Pauling are surveyed. Experiments were conducted in which the infrared spectra of KCN in KCl and KBr single crystals were studied. The results indicate that free rotation of the molecules occurs at 60°K, that the C—N bond length in KCl is 1.36 A, and that strong phonon interactions occur. It is concluded that Pauling's model of the rotational degrees of freedom is verified. (D.L.C.)

1052 (ORNL-3676) SOLID STATE DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING MAY 31, 1964. (Oak Ridge National Lab., Tenn.). Oct. 1964. Contract W-7405-eng-26. 203p. Dep.; $6.00(cy), 4(mn) OTS.

Separate abstracts were prepared for 19 of the 21 sections; the two remaining parts report programs on quantum mechanical calculations for molecules of interest in photosynthesis, and on a thermal-neutron irradiation facility. (R.E.U.)

For abstracts of individual sections see: 346, 428, 728, 778, 850, 959, 960, 961, 998, 999, 1000, 1001, 1002, 1003, 1004, 1167, 1168, 1169, and 1484.

1053 (PR-P-62) PHYSICS DIVISION PROGRESS REPORT, APRIL 1 TO JUNE 30, 1964. (Atomic Energy of Canada Ltd. Chalk River Nuclear Labs., Chalk River, Ont.). 59p. (AECL-2044). Dep.; $1.50(AECL).

Two high-resolution techniques were developed to study the closely spaced energy levels above 9 Mev excitation in ^{20}Ne. Using one method, γ rays from the reaction $^{19}F(d,n\gamma)^{20}Ne$ are studied in a good-resolution Li-drifted Ge spectrometer as a function of the deuteron beam energy. A pulse shape discrimination, which rejected many of the pulses from electrons passing through the walls of the γ-ray detector, was used and gave a peak to background improvement of about a factor of two. Using a second method, γ-rays from the reaction $^{12}C(^{12}C,\alpha\gamma)^{20}Ne$ were studied using a 5-in. × 6-in. NaI(Tl) scintillator counter in coincidence with α-particle groups selected in the high resolution magnetic spectrometer. The α-spectrometer was adjusted to minimize kinematic energy spreads. Using these techniques at excitations from 9.3 to 12.3 Mev in ^{20}Ne, 13 levels including 4 closely spaced doublets or triplets were estab-

lished along with the dominant mode of γ-ray decay from each level. The second method was also used with the reaction $^{12}C(^{16}O,\alpha\gamma)^{24}Mg$ to study levels in ^{24}Mg. 14 levels at excitations in ^{24}Mg between 7.5 and 10.1 Mev were established along with the modes of γ-ray de-excitation. For 3 of these levels the energies and observed transitions are consistent with an assignment as high spin members of known K = 0+ and K = 2+ rotational bands in ^{24}Mg. One of the interesting intensity variations observed in cosmic radiation is a small fluctuation (~0.3%) with a period of one solar day, and with an amplitude and phase which vary considerably over periods of a few days. This diurnal variation, which implies a slight dependence of cosmic radiation on direction in space, is believed to be caused by the small magnetic fields now known to exist between the sun and the earth. For the past 2 yr continuous records of the cosmic radiation were made at Deep River using a large plastic scintillator meson monitor along with the sensitive neutron monitor. The meson monitor measures the variation at a higher primary cosmic-ray energy than the neutron monitor. A recent analysis of the data from the two monitors shows that corrections for atmospheric diurnal effects are small and that the true cosmic-ray diurnal variation can be followed accurately in both monitors. The observed ratio of the yearly average meson-to-neutron diurnal variations for the year 1962–63 indicates that the anisotropic components of the cosmic radiation contains energies no higher than about 50 Bev. It is interesting that this is lower than the estimated upper limit of 200 Bev obtained from other work for the IGY years 1957–58. Further studies are needed to determine whether there has been a real change in the hardness of the anisotropic component. 23 new high-efficiency cosmic-ray neutron monitors were ordered for stations distributed about the earth. Four of these will be at Inuvik, Churchill, Goose Bay, and Alert in northern Canada and by virtue of the high latitude each will have the property that the primary charged particles which they detect arrive from a very narrow angle window in space outside the earth's magnetic field. The window for the station at Alert is directed along the spin axis of the earth and the windows for the three other stations are in the equatorial plane at widely different longitudes. The equipment at three of these stations is being supplied by AECL and it is expected these stations will become operative during 1964–65. The normal vibrations in a single crystal of Mo were studied further using the triple axis crystal spectrometer at the NRU reactor. Several normal modes were compared at 100 and 296°K. The frequencies were found to be about 1% greater at 100 than at 296°K, which is consistent with the known temperature variation of the elastic constants. No changes in the widths of the neutron groups could be detected, probably due to a large instrumental contribution to the observed widths. Detailed measurements of the longitudinal dispersion curve in the crystal direction [ζ ζ ζ] revealed one strong anomaly and two or more weak ones in the slope of the curve. The positions of these anomalies correlate well with known features of the conduction electron momentum Fermi surface of Mo and suggest that they are Kohn anomalies similar to those observed in Pb. A number of programs were developed or improved for use on the G-20 computer. The program for calculations of cross sections based on the statistical model was extended to include reactions in which two particles are emitted from the compound nucleus. A series of programs for working directly with matrices of complex numbers is being prepared to provide more efficient use of the computer. Programs for making a file of family related records from files of raw vital statistics records were developed using new techniques. The G-20 was purchased on April 1, 1964. Use of the machine has continued to increase during this quarter and averaged 275 hours per month. Use of the Datatron decreased slightly to an average of 65 hours per month. (auth)

1054 (PUC-1964-153) TOPICS IN THE THEORY OF RANDOM MATRICES (thesis). Burt V. Bronk (Princeton Univ., N. J. Palmer Physical Lab.). Sept. 1964. Contract AT(30-1)-937. 118p. Dep.(mn); $4.00(cy), 2(mn) OTS.

The history of the theory of random matrices is reviewed. The reasons why the statistical properties of matrices are of interest for physics are discussed, and various statistical properties of quantum mechanical systems are indicated in order to show what sorts of properties one eventually should understand when the mathematics of the theory is further advanced. The need for an expression for the density of energy levels of hamiltonians of complex systems is discussed. Ensembles obeying the semicircle law have provided an explanation of observed nearest-neighbor spacings, but the semicircle law is unlike the level density observed for nuclear spectra. Deviations from that law are therefore investigated in the vicinity of the lowest energy levels. Convexity of the graph of the density of levels plotted against energy on the horizontal axis is the criteria assumed so that the graph show some similarity to the exponential dependence believed to exist in nuclear spectra. A region of convexity is found to exist, but it is shown that the region contains only two eigenvalues even when the dimension of the matrix is very large. It is therefore concluded that those ensembles of random matrices investigated so far, do not provide a fair representation for complex hamiltonians. A relation is shown to exist between zeros of the classical polynomials and the eigenvalues of random matrices. This relation reflects the sharp cut-off mentioned, which makes the level density beyond a certain point go rapidly to zero. An ensemble called the "exponential" ensemble, is introduced. By means of this ensemble, restriction to the space of all positive matrices can be made. The joint distribution function for the eigenvalues of these matrices is derived. A semiclassical derivation based on Schroedinger's equation for the hydrogen atom is used to obtain the single-level density formula. This is the first case where such an ensemble, which does not obey the semicircle law, has been explicity exhibited. Invariance properties of the single-level density formula are explored by changing in various ways, the measure on the matrices. It is found that although the graph of the density is not invariant with respect to the form of the measure, it does retain important features of its shape for many different measures. (auth)

1055 (SC-RR-64-1207) BRAGG SCATTERING FROM A CRYSTALLINE POWDER OF BERYLLIUM IRRADIATED BY A CONTINUOUS X-RAY SPECTRUM. Frank Biggs (Sandia Lab., Albuquerque, N. Mex.). Aug. 1964. Contract [AT(29-1)-789]. 18p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Where it is assumed that a continuous spectrum of x rays is incident on the sample, the x-ray spectrum scattered from a sample of crystalline powder beryllium by Bragg reflections is calculated. This calculation is made for the important crystal planes and for the first three orders. (auth)

1056 (CEA-tr-A-1471) L'INFLUENCE DES RAYONS RADIOACTIFS ET DE CHARGES SPATIALES SUR LA TRAJECTOIRE DE LA FOUDRE. (The Influence of Radioactive Radiation and of Space Charge on the Trajectory of Lightning). Dietrich Mueller-Hillebrand (France. Commissariat à l'Energie Atomique. Centre d'Etudes Nucléares, Saclay). Translated into French by M. Makarius from Elektrotech. Z., A, 83: 152-7(1962). 25p. (Includes original, 6p.). Dep.(mn); $2.60(fs), $0.95(mf) JCL.

The static electric field strength in the vicinity and below a thunder cloud is at ground level seldom greater than 10 kv/m and often only 3 kv/m in lightning at several hundred m from the measurement point. This is the result of the space charge produced in the form of coronal discharge at all points of the ground. The space charge produced by a single very high point can have an effect on the trajectory of the lightning. For the experimental verification of whether the coronal current can be affected by radioactive points of various intensities, measurements were carried out in electric fields of different intensities. In the laboratory no difference could be detected in the coronal discharge for points with and without radium coating. In plain air, on the contrary, the current for radioactive points was always less than that for non-radioactive points. When the

intensity of the electric field is increased, the ionic cloud of the radioactive points delays the release of the coronal discharge. It was shown experimentally that coronal discharges attaining 8 mamp can change sharply the intensity of the electric field in a large radius around the origin. In the summer of 1961, however, experimental proof of the effect on a lightning discharge at a distance of several hundred meters could not be obtained. It was established that the coronal discharge emitted by very high points has an effect on the lightning trajectory. The currents emitted by radioactive lightning rods are too weak to create the space charges necessary; they could be a hundred thousand times greater to cause a change of the electric field at a distance of several hundred meters. (tr-auth)

1057 PRECURSOR PHENOMENA OF INTENSE SHOCK WAVES IN ARGON. Pierre Valentin and Jean-Claude Leboucher (Commissariat à l'Énergie Atomique, Paris). Compt. Rend., 259: 1037-9(Aug. 3, 1964). (In French)

Precursor phenomena of shock waves in rare gases are characterized by the presence of electrons at some distance in front of the wave. These electrons would possibly be carried by scattering on the walls of atoms excited to a metastable level, or by photoionization of metallic walls. The results do not seem favorable to this last hypothesis. The presence of electrons and ions in precursor phenomena is established. (tr-auth)

1058 MEASUREMENT OF ELECTROMAGNETIC EXTRUSION FROM AN ELECTRICALLY CONDUCTING LIQUID. U. Ts. Andres and L. S. Polyak. Inzh. Fiz. Zh., 7: No. 8, 121-3(Aug. 1964). (In Russian)

Methods for determination of the buoyancy force on bodies submerged in an electrically conducting liquid carrying electrical current in a magnetic field are presented. Relations are obtained for the electromagnetic component of the buoyancy force on conducting and non-conducting spheres (d = 2.25 cm). (auth)

1059 MAFCO—A MAGNETIC FIELD CODE FOR HANDLING GENERAL CURRENT ELEMENTS IN THREE DIMENSIONS. W. A. Perkins and J. C. Brown (Univ. of California, Livermore). J. Appl. Phys., 35: 3337-43(Nov. 1964). (UCRL-7744)

The program MAFCO, in FORTRAN for the IBM 7094 and other similar computers that will compile a machine language code from a FORTRAN deck, takes a given set of current-carrying elements of arbitrary geometry and calculates the magnetic field b at any point in space, as well as the continuation of the magnetic field line (line of force) passing through any desired point in space. Computer memory and available machine time usually require that most of the current-carrying conductors be approximated by straight lines and circular loops. (auth)

1060 KINETIC APPROACH TO THERMAL TRANSPORT PHENOMENA. I. CLASSICAL THEORY. N. Hashitsume and S. Fujita (Université Libre, Brussels). J. Math. Phys. (N. Y.), 5: 1572-9(Nov. 1964).

Assuming noninteracting particles, which are scattered by randomly arranged static potentials, such as free electrons in a low-temperature semiconductor containing impurity atoms, the expressions of thermal transport coefficients are derived by means of the kinetic approach established by Prigogine et al. In this part, the classical law of mechanics is assumed, and the case of zero magnetic field is discussed. It is shown that the thermal transport coefficients thus obtained can be expressed in the terms of the correlation functions of suitable currents in the same way as the Kubo formula for the electric conductivity. (auth)

1061 PERTURBATION VARIATION METHODS FOR A QUANTUM BOLTZMANN EQUATION. R. F. Snider (Univ. of British Columbia, Vancouver). J. Math. Phys. (N. Y.), 5: 1580-7(Nov. 1964).

For molecules with degenerate internal states, the single-particle distribution must be replaced by a density matrix, or better, if the translational motion is treated classically, by a Wigner distribution-function density matrix. The modified Boltzmann integro-differential equation for this quantity was previously derived but so far only limited solutions of the resulting equation were obtained. Methods are discussed which enable the standard methods for the solution of the classical Boltzmann equation to be applied to the solution of this equation. Complications involving commutation properties are resolved. (auth)

1062 LAGRANGIAN FORMULATION OF THE PHONON FIELD EQUATIONS. Arnold D. Levine (West Virginia Univ., Morgantown). J. Math. Phys. (N. Y.), 5: 1615-18 (Nov. 1964).

The equations of motion of lattice vibrations are formulated with the action principle as a starting point. As a result, one obtains, in addition to the equations of motion, the conservation laws for energy and momentum. The latter are contained in a set of finite difference equations. Boundary conditions on the field variables must be specified over a region equal to one lattice spacing in order for the entire procedure to be meaningful. The quantized version of the theory can be constructed in a conventional way, and the commutators of the field variables exhibit a set of periodically spaced singularities. In this way a field is constructed which is nonlocal with respect to its dependence on space variables, but is local with respect to its time dependence. (auth)

1063 EFFECT OF A VERY STRONG UNIFORM MAGNETIC FIELD ON MAGNETO-FLUID DYNAMIC TURBULENCE. Michio Ohji (Kyushu Univ., Fukuoka, Japan). J. Phys. Soc. Japan, 19: 1430-9(Aug. 1964).

A first-order theory is presented for turbulence of an electrically conducting fluid in the presence of a uniform magnetic field which is so strong that the nonlinear mechanism as well as the dissipation terms are of minor importance compared with the external coupling terms. The response of an initially isotropic turbulence to a suddenly imposed uniform magnetic field is worked out in detail. It is concluded that energies associated with the mechanical and the magnetic modes of turbulence asymptotically approach to the state of equi-partition provided that the macro-scales of the two modes are not widely different. Some numerical discussions are made in connection with the physical relevance of the theory. (auth)

1064 EXTENSION OF THE M^2 AND THE THIN-WING-EXPANSION METHODS TO MAGNETOHYDRODYNAMICS. Kinzo Hida (Univ. of Cincinnati). J. Phys. Soc. Japan, 19: 1451-7(Aug. 1964).

On the basis of a reduced equation for steady, two-dimensional flow of a perfectly conducting gas with an aligned magnetic field, the M^2-expansion method as well as the thin-wing expansion method is extended to include the effect of a magnetic field. General formulas obtained by both methods remain unchanged, except that the parameters involved should be read as given. The transonic thin-airfoil theory is also modified for magnetohydrodynamical flow, and it is found that the same similarity rule for the flow past a slender body holds for both nonmagnetic and magnetic cases with the proper alteration of the parameters. (auth)

1065 SWIRL OF A CONDUCTING GAS DUE TO THE HALL EFFECT. Hidenori Hasimoto (Tokyo Univ.). J. Phys. Soc. Japan, 19: 1457-63(Aug. 1964).

The Hall effect is shown to induce a swirling or transverse motion in the flow of an electrically conducting gas in a magnetic field and surrounded by an insulating medium. Both the two-dimensional and the axi-symmetric flows are discussed. On the assumption that the magnetic Reynolds number and the magnetic interaction parameter are small, the transverse or helical velocity is shown to be independent of the Mach number to first order approximation. This velocity is explicitly determined for a slender symmetric flow with small Hall parameter in terms of the imposed magnetic field along the axis. A numerical example is given for a magnetic field of a single current loop. (auth)

1066 THE FUNDAMENTAL EQUATIONS OF MAGNETOHYDRODYNAMICS IN ANISOTROPIC MEDIA. Iván Abonyi (Roland Eötvös Univ., Budapest). Magy. Fiz. Folyoirat, 12: 245-9(1964). (In Hungarian)

The fundamental equations of magnetohydrodynamics were

derived from the Maxwell equation and the Napier-Stokes equation, which describe the motion of the medium. It is assumed thereby that the dielectric constant ϵ is a place- and time-independent scalar magnitude and the permeability μ is equal everywhere and always to unity while the electrical conductivity σ is also scalar, reaching values of the order of magnitude of the metals. The convection current may be neglected in comparison with the conductive current and the relativistic phenomena do not have to be taken into consideration. The equations were derived for the case in which the material characteristics of the medium ϵ, μ, and σ, are place-dependent anisotropic tensors, assuming at the same time that the determinant of these tensors are not zero. The equations derived on the basis of the known material characteristics must be supplemented with an equation defining the magnetic viscosity tensor, the equation of state, and the kinetic equation. When isotropic constants are substituted in this system, the original fundamental equations are obtained again.(TTT)

1067 THE MAGNETOHYDRODYNAMIC DYNAMO THEORY. Imre Csada (Astronomical Observatory, Hungarian Academy of Sciences). Magy. Fiz. Folyoirat, 12: 261-6(1964). (In Hungarian)

The magnetohydrodynamic dynamo theory involves the discussion of the conditions of existence of large magnetic fields for extended periods of time; such field may be observed primarily in astrophysical studies. The theory is reviewed on the basis of the usual magnetohydrodynamic equations, such as the kinetic equation, Ohm's law, and the magnetic field equation. Members of these equations, relating to the interaction of the velocity field and the magnetic field, are of interest for this discussion. In addition to theoretical derivations, direct astrophysical observations were also included in the review of the problem. The velocity field of the Sun's atmosphere is a resultant of the axial movement and the meridional flow. On the basis of the observations, a number of acceptable functions was applied for the calculation of the tensor elements. The results indicated that the first member creates a dipole and the second, an octupole field; the moments of the two components change periodically with a small phase difference. The periodic variations agree with the 22-year cycle of the Sun. By including this solution in the kinetic equation, a damping of the velocity field is obtained; the characteristic time of this damping for the Sun in the case of turbulent dissipation is of the order of 10^7 to 10^8 years. Thus, the dynamo theory increases the original damping period by a factor of 10^4 to 10^5; at the same time, the magnetic field is also decreased. (TTT)

1068 RESEARCH AT EURATOM—A SURVEY ONE YEAR AFTER THE DECISION OF THE SECOND FIVE-YEAR PROGRAM. H. H. Haunschild. Neue Tech., 5: 573-84(1963). (EUR 1691.d). (In German)

The European Atomic Energy Community's second five-year research and training program for the period 1963–1967 was adopted by the Council of Ministers in the summer of 1962. This 1963 was a particularly significant year, as it covered the transition from the first to the second program. The main features at the outset of the new program were, first and foremost, the continuation of work begun under the first program, with particular reference to the further expansion of the four Joint Nuclear Research Center establishments. The Community has lost no time in embarking on its new tasks, as witnessed by the fact that under the 1963 and 1964 budgets commitments will have been entered into for as much as two-thirds of the allocation for the second program. The new program has had to be cut back in certain other fields, however. The state of progress attained and the projected further development of the four Joint Nuclear Research Center establishments, and also the importance of the research contracts and the fields of research covered by contract, are reviewed. Even in the first year, various amendments and additions to the five-year program were suggested. The Commission submitted to the Member States a scheme to found a Physics Department at Ispra. The French proposal to set up a European Nuclear Science Training Institute at Saclay is to be examined, likewise the SORA reactor project. (auth)

1069 THE ECONOMICS OF SUPERCONDUCTING MAGNETS. G. P. Haskell and P.F. Smith (Rutherford High Energy Lab., Chilton, Berks, Eng.). Nucl. Instr. Methods, 30: 277-82(Nov. 11, 1964).

The results of a survey of the relative costs of superconducting and conventional magnets are summarized. It is concluded that the minimum current densities and magnetic fields required for the majority of potential applications in high-energy physics are well within the forseeable future performance of known superconductors. (auth)

1070 SPECTROSCOPIC STUDIES OF "WEAK" AND "STRONG" HIGH-FREQUENCY DISCHARGES IN THE INERT GASES. O. P. Bochkova and L. P. Razumovskaya. Opt. Spectry. (USSR) (English Transl.), 17: 8-11 (July 1964). Translated from Optika i Spektroskopiya, 17: 16-23(July 1964).

High-frequency discharges in the inert gases were studied in the region in which their properties show an abrupt change. In weak and strong high-frequency discharges in helium, neon, and argon the electron temperature and the concentration of excited atoms were studied as functions of the initial pressure, the diameter of the discharge tube, and the electron concentration in the discharge. The results obtained are used as the basis of a discussion of the mechanism of populating and quenching the excited states of helium, neon, and argon in weak and strong high-frequency discharges at low pressures. (auth)

1071 THE CONCENTRATIONS OF EXCITED ATOMS IN A PULSED DISCHARGE IN HELIUM. V. S. Egorov, Yu. G. Kozlov, and A. M. Shukhtin. Opt. Spectry. (USSR) (English Transl.), 17: 82-3(July 1964). Translated from Optika i Spektroskopiya, 17: 154-6(July 1964).

An interferometer and a double electric probe were used to measure the concentration of excited He atoms, the concentrations of charged particles, and the temperature of the electron gas at various stages of a pulsed discharge. The concentration of excited atoms was determined by the Rozhdestvenskii hook method using He 3889, 3965, and 5876Å. (C.E.S.)

1072 GENERALIZED BOLTZMANN EQUATION FOR A QUANTUM GAS. S. Fujita (Université Libre, Brussels). Phys. Letters, 12: 300-1(Oct. 15, 1964).

The Boltzmann equation is written for a quantum gas of interacting, distinguishable particles in constant electric and magnetic fields. (T.F.H.)

1073 TRANSPORT COEFFICIENTS FROM CORRELATION FUNCTIONS AND DISTRIBUTION FUNCTIONS. E. G. D. Cohen (Rockefeller Inst., New York), J. R. Dorfman, and M. H. J. J. Ernst. Phys. Letters, 12: 319-20 (Oct. 15, 1964).

The viscosity of a gas is expressed in terms of the particle correlation functions. The correlation functions are modified in such a fashion that only the behavior for times much greater than the average collision time is required. A density expansion for the viscosity is found by this method, the first two terms of which agree with the results calculated from the distribution functions alone. (T.F.H.)

1074 INHOMOGENEOUS ELECTRON GAS. P. Hohenberg (Universitè, Paris) and W. Kohn. Phys. Rev., 136: B864-71(Nov. 9, 1964).

The ground state of an interacting electron gas in an external potential $v(r)$ is studied. It is proved that there exists a universal functional of the density, $F[n(r)]$, independent of $v(r)$, such that the expression $E \equiv \int v(r)n(r)dr + F[n(r)]$ has as its minimum value the correct ground-state energy associated with $v(r)$. The functional $F[n(r)]$ is then discussed for two situations: $n(r) = n_0 + \tilde{n}(r)$, $\tilde{n}/n_0 \ll 1$; and $n(r) = \varphi(r/r_0)$ with φ arbitrary and $r_0 \to \infty$. In both cases F can be expressed entirely in terms of the correlation energy and linear and higher order electronic polarizabilities of a uniform electron gas. This approach also sheds some light on generalized Thomas-Fermi methods and their limitations. Some new extensions of these methods are presented. (auth)

1075 SURFACE INTEGRAL FORM FOR THREE-BODY COLLISION IN THE BOLTZMANN EQUATION. M. S. Green (National Bureau of Standards, Washington, D. C.). Phys. Rev., 136: A905-10(Nov. 16, 1964).

A new form is given for the triple-collision term in the generalized Boltzmann equation which is more similar to the well-known binary-collision expression than those given heretofore. The form involved is a surface integral over a five-collision parameter space which is the generalization of the two-dimensional collision parameter space for binary collisions. For soft repulsive interactions, the expression involves both the asymptotic properties of three-body collisions before and after the collision, and the dynamics of binary collisions during the collision process. For hard spheres, the expression involves only the asymptotic properties of ternary and binary collisions. (auth)

1076 EINSTEIN RELATIONS CONNECTING BROADBAND EMISSION AND ABSORPTION SPECTRA. D. E. McCumber (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., 136: A954-7(Nov. 16, 1964).

Relations described by Einstein connecting the rates of spontaneous emission, stimulated emission, and absorption of radiation by an atomic system in free space are generalized to apply to broadband spectra of quantized systems dilutely distributed in a dielectric medium. Although the gross features of the broadband emission and absorption spectra can be qualitatively different (especially at low temperatures), the various spectra are connected at any specific frequency by simple expressions. For a two-level system imbedded in a medium at temperature T, typical equations connecting stimulated-emission and absorption cross sections $\sigma(\omega)$ to the rate $f(\omega)$ of spontaneous emission of photons per unit solid angle per unit frequency interval are: $\sigma_e(\omega) = \sigma_a(\omega) \exp[\hbar(\mu - \omega)/kT] = f(\omega)(2\pi c/\omega n)^2$, where $\hbar\mu$ is a temperature-dependent excitation potential and n is the index of refraction of the host material. (auth)

1077 INDEX OF REFRACTION OF HELIUM IN THE SHIELDING APPROXIMATION. Boris Musulin and Saul T. Epstein (Univ. of Wisconsin, Madison). Phys. Rev., 136: A966-8(Nov. 16, 1964).

The index of refraction of the helium isoelectronic sequence at low frequencies was calculated using the shielding approximation. When compared with experiment for helium, the accuracy is found to be comparable to that typical of the shielding approximation for static properties, about 10%. Brillouin's theorem is extended to time-dependent problems. (auth)

1078 ANISOTROPIC ENERGY LOSS OF LIGHT PARTICLES OF Mev ENERGIES IN THIN SILICON SINGLE CRYSTALS. C. Erginsoy (Brookhaven National Lab., Upton, N. Y.), H. E. Wegner, and W. M. Gibson. Phys. Rev. Letters, 13: 530-4(Oct. 26, 1964). (BNL-8374)

A beam of 3-Mev protons is scattered by a 1-mil-thick Si single crystal cut normal to the ⟨11⟩ axes. It is found that: the anisotropy of energy loss is characteristic of the low-index symmetry planes of the crystal, and shows up strongly along crystal axes where such planes intersect; the fraction of the transmitted beam with energies in the "tail" or "shoulder" of the distorted spectrum is relatively independent of the beam collimation; and in addition to the distortion toward high energies, there exists an increase in the energy straggling at the low-energy end of the spectrum. (T.F.H.)

1079 STUDY OF THE PAIR CORRELATION FUNCTION DIAGRAMS. Eugene Helfand and Robert L. Kornegay (Bell Telephone Labs., Inc., Murray Hill, N. J.). Physica, 30: 1481-97(Aug. 1964).

The simple diagrams of seven and less points (doubly-rooted, irreducible diagrams with no parallel connections between the roots) were generated and classified with the aid of a digital computer. The number of graphs of various topological types (basic, nodal, hypernetted chain, etc) which enter into the calculation of the pair correlation was determined in this way, as well as by means of counting series. The integrals represented by the diagrams, and thus the pair correlation function to fifth power in density, have been evaluated for the model which approximates the Mayer f function by a negative Gaussian. Several approximate theories are discussed in the light of these results. (auth)

1080 PROPERTIES OF THE PSEUDO-MARKOVIAN COLLISION OPERATOR. Claude George (Université Libre, Brussels). Physica, 30: 1513-28(Aug. 1964). (In French)

I. Prigogine and P. Résibois recently introduced, as an intermediate step in their formulation of the approach to equilibrium in a homogeneous system, functionals $\Omega_\alpha(z)$ of a given analytical function $\Psi(z)$. An attempt is made to analyze, in a more complete way, the sequence of functionals $\Omega_\alpha(z)$, to establish the link between two methods to describe the pseudo-markovian evolution for the above-mentioned system, and to derive, with a strictly mathematical point of view, from the properties of the functionals $\Omega_\alpha(z)$, a few remarkable equations, leading when particular choices of function $\Psi(z)$ are made to summation relations between binomial coefficients. (auth)

1081 THEORY OF ZERO SOUND IN A NEARLY PERFECT BOLTZMANN GAS. Noboru Takimoto and Barry W. Ninham (Univ. of New South Wales, Kensington, Australia). Progr. Theoret. Phys. (Kyoto), 32: 8-28(July 1964).

Density waves in nearly perfect Boltzmann gases are studied under conditions which invalidate the usual phenomenological theory of sound waves. It is shown that thermal agitation of gas particles behaves as a barrier against the propagation of density waves in an unbounded system and that forced density waves in a system bounded by a single rigid plane vary as $\exp[-(3/2)(\alpha/2)^{1/2}]\cos[(3\sqrt{3}/2)(\alpha/2)^{1/2} - \omega t]$ for large values of α; $\alpha = \sqrt{m/2KT} \cdot \omega z$, where ω is the angular frequency and z is the distance from the plane. The results are discussed with reference to previous experimental work. (auth)

1082 SHOCK PROPAGATION IN INHOMOGENEOUS GASES. V. OBLIQUE SHOCK PROPAGATION. Toshihisa Ishizuka (Hokkaido Univ., Sapporo), Yoshiaki Hashimoto, and Yōrō Ōno. Progr. Theoret. Phys. (Kyoto), 32: 207-19 (Aug. 1964).

The quasi-stationary method is generalized to the case of oblique shock propagation, that is, shock propagation along directions making a finite angle with that of pressure gradient in stratifying media. Two simultaneous differential equations determining the direction and strength of shock are obtained. Its behavior is discussed in detail for polytropic gases. It is characteristic for the oblique propagation that a pattern change, i.e., transition from regular to Mach pattern, occurs ultimately, and a vortex field generates after the passage of the shock. (auth)

1083 REPORTS ON PROGRESS IN PHYSICS. VOLUME XXVII (1964). A. C. Stickland, ed. Rept. Progr. Phys., 27: 1-551(1964). London, The Institute of Physics and the Physical Society, 1964.

Separate abstracts were prepared for six of the ten papers included. Other papers deal with ferroelectrics, matter transport in solids, microwave and optical masers, and volume-controlled current injection in insulators. (D.C.W.)

For abstracts of individual papers see: 400, 830, 1084, 1184, 1305, and 1650.

1084 GREEN FUNCTIONS IN STATISTICAL MECHANICS. W. E. Parry (Oxford Univ.) and R. E. Turner. Rept. Progr. Phys., 27: 23-52(1964).

Thermodynamic perturbation theory is described in terms of temperature-dependent Green functions. The relation of these functions with time-temperature-dependent Green functions and with correlation functions is discussed, and some of their analytic properties are derived. The chain of coupled equations forming the equations of motion of the Green functions is derived and is written in terms of

functional derivatives. Two examples of the use of Green functions — discussions of the sharpness of the Fermi surface and of neutron scattering from liquid helium — are given. The use of Green functions in the theory of relaxation phenomena is described. (auth)

1085 LINEAR STREAMING ABOUT A PLATE BY BLOWING ELECTROCONDUCTING GAS THROUGH ITS SURFACE IN THE PRESENCE OF A MAGNETIC FIELD. Yu. N. Symslov. Tr. Leningr. Politekhn. Inst., No. 230, 54-8(1964).

An analysis has been made to determine the reduction in stagnation point flow when blowing and magnetic field act simultaneously. High-temperature argon containing a small amount of ionizing alkali metal (potassium) vapor was forced through the porous surface of a "semi-infinite" plate. Diffused into the hot stream flow, the vapors are subject to thermal ionization, and an electrically conducting edge layer, interacting with the external magnetic field, develops near the plate. The results suggest that both surface friction and the heat flow can be substantially reduced by using the combined effect of vapor blowing and magnetic field. When blowing is intensified, much smaller magnetic fields are needed to achieve the same effect. (auth)

1086 NEKOTORYE VOPROSY TEORETICHESKOI FIZIKI. (Some Problems in Theoretical Physics). D. V. Skobel'tsyn, ed. Trudy Fiz. Inst., Akad. Nauk SSSR, 16: 1-166(1961).

Three articles are presented. Separate abstracts have been prepared for each. (R.V.J.)

For abstracts of individual papers see: 1463, 1464, and 1652.

1087 A VARIABLE SHADOW PROCEDURE FOR EXACT DETERMINATION OF GEOMETRICAL-OPTICAL DATA ON ELECTRON BEAM SOURCES AND ELECTRON LENSES. Karl-Joseph Hanszen (Physikalisch-Technische, Bundesanstalt, Ger.). Z. Naturforsch., 19a: 896-905(July-Aug. 1964). (In German)

A device is built in which the displacement in the y direction of a microslit near the anode is coupled with the shifting in the x direction of a photoplate on which the shadow picture of the microslit is taken. The picture curve thus obtained gives quantitative indications on axis point of interaction and inclination of the slotted beam and on the caustic behavior in the total beam bundle. New data on the characteristics of electron beam sources and improved measurements on electron lenses were reported on the basis of some examples of applications. (tr-auth)

1088 TIME-WISE DEVELOPMENT OF A TOWNSEND DISCHARGE UP TO BREAKDOWN. W. Koehrmann (Universität, Hamburg). Z. Naturforsch., 19a: 926-33 (July-Aug. 1964). (In German)

For a plane discharge in hydrogen ($p\,d$ = 1000 Torr cm), the current rise of the Townsend discharge was calculated; the calculation begins in the original (space-charge free) development and carries through to the stage in which the space charge of the positive ions and the electrons is effective up to the region of the voltage drop at the discharge gap. The model contains the carrier motion and collision ionization, as well as photoelectric supplements on the cathode. The effect of the field strength, which is connected via the Poisson equation with the resulting space charge of the ions and electrons, is essential in these processes. The phases in the development of the discharge can be distinguished. During the original space-charge buildup, the development of the current experiences an acceleration. In the next stage a cathode drop is built that accepts the supply of electrons for the remaining region. A further current rise in this range is taken up by an ionization wave; the wave moves (with about five-fold electron drift velocity) from the anode in the direction of the cathode. In the final stage the discharge consists of the cathode drop and a connected plasma in which no notable ionization occurs. The limited conductivity of this plasma has, in connection with the resistance connecting the discharge gap, the result that the voltage is only partially broken down at the electrode gap. The result of the theoretical calculation satisfies the experimental results. (tr-auth)

1089 ENGINEERING ASPECTS OF MAGNETOHYDRODYNAMICS. Proceedings of the Third Symposium, Rochester Univ., March 28-29, 1962. Norman W. Mather and George W. Sutton, eds. New York, Gordon and Breach Science Publishers, 1964. 668p. $34.50. (CONF-101)

The engineering aspects of magnetohydrodynamics are discussed including diagnostics and communications, energy conversion, flight applications, and fusion. Separate abstracts are prepared for 31 of the 37 papers presented. Abstracts of 6 papers previously appeared in NSA (16: 16011, 18697, and 21847 and 17: 16188, 21136, and 42143). (C.E.S.)

For abstracts of individual papers see: 1164, 1214, 1215, 1216, 1217, 1218, 1219, 1220, 1221, 1222, 1223, 1224, 1792, 1793, 1794, 1795, 1796, 1797, 1798, 1799, 1800, 1801, 1802, 1803, 1804, 1805, 1806, 1807, 1808, 1809, and 1810.

1090 BASIC METHODS IN TRANSFER PROBLEMS. RADIATIVE EQUILIBRIUM AND NEUTRON DIFFUSION. V. Kourganoff. Dover Books on Advanced Mathematics. New York, Dover Publications, Inc., 1963. 294p. $2.00.

Methods for approximate and exact solution of transfer problems are reviewed, using the Milne problem for a plane parallel atmosphere or medium as an illustration of the different methods. (D.C.W.)

1091 ANALYTICAL AND CANONICAL FORMALISM IN PHYSICS. Andre Mercier. Dover Books on Advanced Mathematics. New York, Dover Publications, Inc., 1963. 228p. $1.75.

The variational principles of the different branches of physics are surveyed, with consideration of the relations among them. The Lagrangian formalism and densities, canonical formalism, canonical form of electrodynamics, hamiltonian densities, transformations, and canonical formalism with vanishing Jacobian determinant are covered. (D.C.W.)

Accelerators

Refer also to abstract 756.

1092 (CEAL-1012) RESEARCH WITH 6-Gev CAMBRIDGE ELECTRON ACCELERATOR. M. Stanley Livingston (Cambridge Electron Accelerator, Mass.). Oct. 6, 1964. Contract AT(30-1)-2076. 16p. (CONF-724-2). Dep.(mn); $1.00(cy), 1(mn) OTS.

From German Physical Society Conference, Dusseldorf, Ger., Oct. 1964.

A summary is presented of research work at the Cambridge Electron Accelerator using the electron and photon beams that are available up to 6 Bev. A description of the electron synchrotron, and some experiments on electron scattering, photon pair production, photoproduction of mesons, and some bubble chamber studies are presented. (R.E.U.)

1093 (JAERI-1063) RADIATION CONTROL AT THE 20-Mev LINEAR ELECTRON ACCELERATOR IN JAERI. Yoshikazu Yoshida, Kyoshiro Kitano, Masahiko Serizawa, and Tadao Shiraishi (Japan Atomic Energy Research Inst., Tokyo). Feb. 1964. 36p. (In Japanese). Dep.(mn)

A 20-Mev Linear Electron Accelerator with 50-meter neutron flight-path was constructed in JAERI in January 1963. For the radiation protection after completion, stray radiations during operation around the LINAC, radioactive gases and dusts in the target room, and exposures to the induced radioactivities were measured in the test operation. The results obtained from the measurement, and the radiation protection system to be adopted for the machine

are discussed, and also the problems of radiation control. (auth)

1094 (JAERI-6014) CONSTRUCTION AND OPERATION OF LINAC. (Japan Atomic Energy Research Inst., Tokyo). Mar. 1963. 90p. (In Japanese). Dep.(mn).

Construction of a 20-Mev microwave electron linear accelerator and associated facilities at JAERI Tokai Research Establishment is described. The important operating characteristics of the accelerator are summarized. Standard procedure of the machine operation is given. (auth)

1095 (JINR-P-1738) TOKOVAYA SISTEMA RELYATIVISTSKOGO TSIKLOTRONA S PROSTRANSTVENNOI VARIATSIEI NA ENERGIYU PROTONOV 700 Mev. (A Current System for 700-Mev Relativistic Cyclotron With Space Variation). S. B. Vorozhtsov, V. P. Dmitrievskii, B. I. Zamolodchikov, N. L. Zaplatin, V. S. Kybalko, L. A. Sarkisyan, and Wei-chiang Chao (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Problems). 1964. 31p. Dep.(mn).

The results of a model investigation of the magnetic field of the current coils for a relativistic cyclotron with proton energy of 700 Mev are given. (auth)

1096 (NASA-CR-56934) CONFERENCE ON HIGH-ENERGY CYCLOTRON IMPROVEMENT, COLLEGE OF WILLIAM AND MARY, FEBRUARY 6-8, 1964. (College of William and Mary, Williamsburg, Va.). 380p. (N64-28163; N64-28167; CONF-519). $21.00(OTS).

Separate abstracts were prepared for 26 of the 31 papers presented; four were previously abstracted for NSA (17: 38305; 18: 24249, 31916, and 40101), and the remaining paper contains a summary of operating characteristics of existing f-m synchrotrons. (R.E.U.)

For abstracts of individual papers see: 1097, 1098, 1099, 1100, 1101, 1102, 1103, 1104, 1105, 1106, 1107, 1108, 1109, 1110, 1111, 1112, 1113, 1114, 1115, 1116, 1117, 1118, 1119, 1120, 1121, and 1122.

1097 (NASA-CR-56934(p.3-15)) BEAM LOSS BY A BEAM-INDUCED CROSS-MODE IN THE RF-ACCELERATION PROGRAMME OF THE CERN 600-Mev SYNCHROCYCLOTRON. H. Beger and A. Fiebig (European Organization for Nuclear Research, Geneva).

Beam losses were detected from beam intensity measurements by a thermocouple target as function of the radius in parallel with activation measurements in the vacuum tank as function of radius at a radius of 200 cm in the CERN-PS. An r-f monitoring system was used to establish the existence of a cross-mode at 200 cm, and methods of elimination of the parasitic mode of oscillation are discussed. (R.E.U.)

1098 (NASA-CR-56934(p.16-23)) SOME REMARKS ON INDUCED RADIOACTIVITY. M. Barbier (European Organization for Nuclear Research, Geneva).

Some materials considerations for existing synchrotrons to allow beam intensity increases without prohibitive increase in induced radioactivity are discussed. A "danger parameter" is defined and given for many common materials of construction. Reduction of radiation field by introducing distributed absorbers in cyclotrons is discussed. (R.E.U.)

1099 (NASA-CR-56934(p.24-34)) PRELIMINARY INVESTIGATION OF FACTORS AFFECTING EXTERNAL BEAMS FROM THE CERN SYNCHROCYCLOTRON. L. Dick, L. di Lella, L. Feuvrais, and M. Spighel (European Organization for Nuclear Research, Geneva).

Factors affecting the intensity and quality of the external pion (100 and 70 Mev) and proton beams of the CERN-PS were studied. Consideration was given to the shielding wall pipe (collimator diameter, beam intensity distributions, thickness of pion extraction window, and losses due to scattering in air. (R.E.U.)

1100 (NASA-CR-56934(p.35-58)) THREE YEARS OF DEVELOPMENT AT THE CERN SYNCHROCYCLOTRON. P. Lapostolle (European Organization for Nuclear Research, Geneva).

Developments associated with attempts to increase beam intensity and machine performance are discussed. The use of an admixture of argon to the ion source gas, incorporation of a central auxiliary Dee, r-f amplitude modulation, increase in magnetic field, use of a vibrating target, and "stochastic Cee" acceleration are considered. (R.E.U.)

1101 (NASA-CR-56934(p.59-68)) IMPROVEMENTS TO THE CERN SYNCHROCYCLOTRON EXTRACTION SYSTEM. M. Morpurgo (European Organization for Nuclear Research, Geneva).

An improved extraction channel for the CERN-PS, suitable for both slow and fast extraction, was designed for future application. Schematic diagrams are shown. (R.E.U.)

1102 (NASA-CR-56934(p.69-74)) THE UPPSALA SYNCHROCYCLOTRON. Ake Svanheden and Helge Tyren (Uppsala Univ.).

The 192-Mev proton synchrotron and beam extraction and transport systems are described. (R.E.U.)

1103 (NASA-CR-56934(p.85-91)) IMPROVEMENT DESIGNS FOR THE CARNEGIE SYNCHROCYCLOTRON. Martyn H. Foss (Carnegie Inst. of Tech., Pittsburgh).

A 30-ft van der Meer type meson channel, an ion source, and an unsuccessful beam extraction device for the Carnegie Synchrotron are described. (R.E.U.)

1104 (NASA-CR-56934(p.108-27)) SOME REMARKS ON THE BERKELEY 184" "CYCLOTRON." Kenneth M. Crowe (California. Univ., Berkeley).

Some recent developments affecting performance and duty cycle of the Berkeley 184-in. cyclotron are described. Ion source, beam monitors, beam extraction, and the synchronized extraction duty cycle are discussed. (R.E.U.)

1105 (NASA-CR-56934(p.128-37)) MULTIPLE "DEE" SYSTEM FOR THE CHICAGO SYNCHROCYCLOTRON. E. H. Molthen (Chicago. Univ.).

The use of power amplifier systems to drive the accelerating electrodes rather than mechanical switching is discussed that is expected to increase intensity by a factor of four. Two main electrodes were used with a peripheral stochastic cee. (R.E.U.)

1106 (NASA-CR-56934(p.138-42)) COLUMBIA UNIVERSITY SYNCHROCYCLOTRON. Marcel Bardon (Columbia Univ., New York).

Some unique features and operational characteristics of the Columbia Univ. synchrocyclotron, and future plans of beam intensification are discussed. (R.E.U.)

1107 (NASA-CR-56934(p.143-51)) THE HARVARD "STOCHASTIC" SYSTEM. B. Gottshalk (Harvard Univ., Cambridge, Mass.).

Some design features of the stochastic accelerating system for the Harvard proton synchrotron are described, and some performance results from the first week of operation are discussed. (R.E.U.)

1108 (NASA-CR-56934(p.152-9)) MONOENERGETIC NEUTRON BEAMS. D. F. Measday (Harvard Univ., Cambridge, Mass.).

The production of monoenergetic neutron beams above 30 Mev at cyclotron facilities is discussed. The experimental lay-out at Harvard where a cyclotron proton beam bombarding a deuterium target is used to obtain neutrons, which are collimated by a concrete wall, is described. (R.E.U.)

1109 (NASA-CR-56934(p.160-5)) FACILITIES FOR BIOLOGICAL AND MEDICAL USES OF THE HARVARD CYCLOTRON. A. M. Koehler (Harvard Univ., Cambridge, Mass.).

The Harvard proton cyclotron and associated equipment used for biological and medical investigations are described. (R.E.U.)

1110 (NASA-CR-56934(p.166-76)) IMPROVING THE HARWELL SYNCHROCYCLOTRON. George Huxtable (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England).

The 110-in. proton synchrotron and proposed modifications to allow deuteron acceleration, increase in internal beam, and more efficient extraction are described. (R.E.U.)

1111 (NASA-CR-56934(p.177-91)) SOME REMARKS ON THE ROCHESTER SYNCHROCYCLOTRON. S. W. Barnes (Rochester, N. Y. Univ.).

The remodeling of the Rochester proton synchrotron is described. Both internal works and shielding were improved with hopes of approaching n = 1. (R.E.U.)

1112 (NASA-CR-56934(p.192-7)) RECENT IMPROVEMENTS TO THE McGILL SYNCHROCYCLOTRON. R. B. Moore (McGill Univ., Montreal).

The magnetic beam extraction and transport systems at the 82-in. proton synchrotron are described. (R.E.U.)

1113 (NASA-CR-56934(p.198-200)) IMPROVEMENTS ON THE PRINCETON 18-Mev SYNCHROCYCLOTRON. Ruby Sherr (Princeton Univ., N. J.).

Beam extraction from the 17-Mev proton synchrotron is discussed. Some performance parameters are given. (R.E.U.)

1114 (NASA-CR-56934(p.237-63)) THE MUON CHANNEL FOR THE CHICAGO SYNCHROCYCLOTRON. I. DESIGN. G. Culligan, H. Hinterberger, H. Oeveras, V. L. Telegdi, and R. Winston (Chicago. Univ. Enrico Fermi Inst. for Nuclear Studies).

The muon channel design for the Chicago Synchrotron is described. An evaluation of the multiple-quadrupole channel is presented. (R.E.U.)

1115 (NASA-CR-56934(p.264-78)) THE MUON CHANNEL FOR THE CHICAGO SYNCHROCYCLOTRON. II. PERFORMANCE. G. Culligan, R. A. Lundy, V. L. Telegdi, R. Winston, and D. D. Yovanovitch (Chicago. Univ. Enrico Fermi Inst. for Nuclear Studies).

The measurement of muon beams from the quadrupole channel at the Univ. Chicago Synchrotron is described. (R.E.U.)

1116 (NASA-CR-56934(p.279-82)) ROTATING CONDENSERS. M. Foss (Carnegie Inst. of Tech., Pittsburgh).

The performance of the Carnegie Institute of Technology's rotating condenser is described. The main bearings and seals are discussed. (R.E.U.)

1117 (NASA-CR-56934(p.283-9)) BEAM STRETCHING BY EXCITATION OF RADIAL OSCILLATIONS. J. R. Wormald (Liverpool. Univ.).

The method and apparatus for beam stretching applied to internally produced pion beams are described. The Dee, Cee, and target configuration in the cyclotron tank is shown. (R.E.U.)

1118 (NASA-CR-56934(p.290-9)) RESIDUAL RADIATION STUDIES. C. B. Fulmer, K. S. Toth, and M. Barbier (Oak Ridge National Lab., Tenn.).

The reliability of estimates based on calculation of residual radiation to be encountered in meson producing accelerators was tested by comparing calculated residual radiation levels with experimental data. A computer calculation was used for determining the γ-ray dose rates near slabs of material after irradiation by a beam of fast protons incident normal to the slab surface. The calculated and experimental decay curves agree within a factor of two or three. Examples of practical application of the calculation are discussed. The study was made for the ORNL Mc^2 Cyclotron. (auth)

1119 (NASA-CR-56934(p.300-5)) ENGINEERING DESIGN OF THE SPACE RADIATION EFFECTS LABORATORY. W. M. Brobeck (Brobeck (William M.) and Associates, [Oakland, Calif.]).

The selection of proton cyclotron design for available energies of 20 to 600 Mev is discussed. The general layout of the laboratory is described. (R.E.U.)

1120 (NASA-CR-56934(p.306-10)) THE USE OF MULTIPLE DEES IN THE FM CYCLOTRON. W. M. Brobeck (Brobeck (William M.) and Associates, [Oakland, Calif.]).

The advantages and disadvantages in using multiple Dees in f-m cyclotrons are discussed. Beam current increases and elimination of moving parts inherent in mechanical frequency modulation are considered. (R.E.U.)

1121 (NASA-CR-56934(p.311-22)) BEAM TRANSPORT SYSTEM FOR THE NASA 600-Mev SYNCHROCYCLOTRON. R. F. Nissen (Brobeck (William M.) and Associates, [Oakland, Calif.]).

The beam transport system for primary protons of 600 and 300 Mev and for degraded beams as low as 20 Mev for the NASA 600-Mev synchrotron is described. (R.E.U.)

1122 (NASA-CR-56934(p.323-36)) THE DESIGN OF A 300-Mev EXTRACTION SYSTEM FOR THE NASA, SREL SYNCHROCYCLOTRON. J. R. Mulady (Brobeck (William M.) and Associates, [Oakland, Calif.]).

The design and projected operation of a 600-Mev proton synchrotron for use in the Space Radiation Effects Laboratory are discussed. The extraction system for the second of the two primary beams (600 and 300 Mev) is described. The peeler-regenerator scheme of beam deflection is described. (R.E.U.)

1123 (PPAD-526-D) A 525-Mev/c K MESON BEAM AT THE PRINCETON-PENNSYLVANIA ACCELERATOR. D. Bowen, A. K. Mann, W. K. McFarlane, D. H. White (Pennsylvania. Univ., Philadelphia); and D. Yount (Princeton Univ., N. J. Palmer Physical Lab.). Sept. 24, 1964. Contract AT(30-1)-2137. 25p. Dep.(mn); $1.00(cy), 1(mn) OTS.

A K meson beam was set up at the Princeton-Pennsylvania Accelerator to study decay modes of the positive kaon. A series of studies was made with a view firstly to maximizing the number of stopping K^+ mesons, and secondly to identifying stopped K^+ mesons reliably. The yield was measured to be ~3 K^+ stopping/10^{10} circulating protons in a scintillator 1" wide by 2" high by 4" along the beam. The number of beam K^- mesons was measured (with negative beam), and found to be 0.1 $K^-/10^{10}$ circulating protons. (auth)

1124 (UCRL-11383) BEVATRON OPERATION AND DEVELOPMENT. 40. OCTOBER–DECEMBER 1963. Kenneth C. Crebbin, William L. Everette, and Walter D. Hartsough (California. Univ., Berkeley. Lawrence Radiation Lab.). July 3, 1964. Contract W-7405-eng-48. 24p. Dep.; $1.00(cy), 1(mn) OTS.

The Bevatron provided beam for 86% of the scheduled operating time. This period included maintenance on the Bevatron and some modifications to the external proton beam extraction system. Extraction efficiencies for the external proton beam were studied for various types of beam spill and energies. Elastic and inelastic p-p scattering, using the external proton beam, was studied. The building radiation surveys continued and the results are given for the new operating conditions. (auth)

1125 HIGH INTENSITY MULTI-Gev PROTON ACCELERATORS. Lee C. Teng (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-11: No. 4, 17-23(Sept. 1964).

For performing many high-energy physics experiments, it is necessary to have high-energy particle beams of very high intensity. The intensity of particle beams in circular proton accelerators in the multi-Bev energy range depends, first, on the number of protons accelerated per pulse and, second, on the number of pulses per second. The number of protons which can be accelerated per pulse is limited by the space charge effects, and the number of pulses per second is limited by the design or type of the accelerator. These intensity limitations and methods of pushing back these limits are discussed. It is now feasible both techno-

logically and economically to construct accelerators in the tens of Bev energy range which will accelerate more than 10^{14} protons per second. (auth)

1126 SUPER-ENERGY ACCELERATORS. Lloyd Smith (Univ. of California, Berkeley). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-11: No. 4, 24-7 (Sept. 1964).

The further development of high energy physics through the next decade will require new accelerators capable of energies of an order of magnitude greater than presently available. A brief review is given of the current status of plans for the super-energy accelerators. Basic parameters are presented for machines in the (200–1000)-Bev energy range and the current study at the Lawrence Radiation Laboratory of a 200-Bev accelerator is described in some detail, as an example of the general class. (auth)

1127 ACCELERATION IN A LINEAR ACCELERATOR OF EMITTED ELECTRONS BY THE EFFECT OF THE U.H.F. FIELD. R. Bergere and A. Veyssiere (Centre d'Etudes Nucleaires, Saclay, France). Nucl. Instr. Methods, 30: 309-30(Nov. 11, 1964). (In French)

The mean and pulse characteristics of the electrons emitted and accelerated by the u-h-f pulse in an electron linear accelerator were studied. It was found that the emission of these electrons is a field-emission at an u-h-f frequency. Some applications are suggested: a cold cathode using an u-h-f field emission; a hot cathode using an u-h-f Schottky effect; and a field emission device emitting polarized electrons into an electron linac. (auth)

1128 THE SOURCE OF PROTON POLARIZATION IN MILAN CYCLOTRON. PART I. THE POLARIZATION OF ATOMIC HYDROGEN. A. Luccio, N. Merzagora, and C. Succi (Università, Milan and Istituto Nazionale di Fisica Nucleare, Milan). Nuovo Cimento (10), 33: 1710-23 (Sept. 16, 1964). (In Italian)

A polarizer of the double magnetic field type that uses a sextupolar lens without iron core was described for the production of a beam of polarized hydrogen. The polarizer, which constitutes the principal element of the polarized proton source, produces a flux of 10^{13} atoms/sec with a polarization degree, with respect to the proton spin, of more than 90%. (tr-auth)

1129 RESONANT ACCELERATORS WITH LONG ACCELERATING GAP. I. E. Teodorescu (Inst. of Atomic Physics, Bucharest). Rev. Roumaine Phys., 9: 487-97 (1964).

A general calculation was made on the accelerating effect of a long gap, in which particles are in interaction with the alternating electric field for almost ½ of the r-f period, for both nonrelativistic and relativistic particles. One can find an optimum value of the gap length, at which maximum gap efficiency is obtained with respect to the particle energy, or to the average beam power for a given value of the electric field strength, or for a given r-f input power. (auth)

1130 BEAM SPREAD WITH THE PRINCETON FM CYCLOTRON. H. O. Funsten, N. R. Roberson, A. Lieber, and R. Sherr (Princeton Univ., N. J.). Rev. Sci. Instr., 35: 1653-7(Dec. 1964). (PUC-1964-142)

Two methods have been employed on the Princeton 18-Mev FM cyclotron to increase the duty cycle of the proton beam. In the first method, the dee oscillator was cut off just before normal beam extraction and turned on again about 50 μsec later. A moderate beam spread is produced. In the second method, an auxiliary accelerating electrode, in the form of a "C" subtending an azimuthal angle of 70° and encompassing the outer 20% of the radial orbits, was added. It is placed opposite the single dee in the region near the deflector and exit channel. In order to produce a spread beam, the regular beam is allowed to enter the region of the C without rf drive on the C. The remaining acceleration necessary for extraction is accomplished by driving the C with an rf program and turning off the dee oscillator. Several frequency-modulation programs were tried: noise, simusoidal, sawtooth, and combinations of these. Sawtooth modulation produced best beam spread. The duty factor (as measured by the ratio of pile-up to single counts from elastically scattered protons using a sodium iodide-scintillation counter) was increased by a factor of about 4 to 5 in the first method and 12 to 15 in the second method. The average current was reduced by a factor of three. However pulsed operation of the dee oscillator makes it possible to use a higher peak dee voltage for the same average power, thereby reducing the loss of current due to stochastic extraction. (auth)

1131 BEAM CURRENT INTEGRATOR. Paul W. Allison (Univ. of Colorado, Boulder). Rev. Sci. Instr., 35: 1728(Dec. 1964). (COO-535-524)

An apparatus for integrating the beam current from a cyclotron is described. The device operates by scaling the output of a voltage-to-frequency converter connected to the Faraday cup. The useful range of the integrator is 0.1 to 1000 nA current and 1 ncoul to 2.6 coul charge. Current dividers are used for currents exceeding 1000 nA. (T.F.H.)

1132 PROTON SCATTERING IN THE TUBE OF AN ELECTROSTATIC ACCELERATOR. Kazimierz Miedzwiedziuk, Leszek Kasinski, and Henryk Malecki. Zeszyty Nauk. Univ. Lodz., Ser. II, No. 9, 23-39(1961).

The most favorable conditions with regard to the scattering of particles accelerated in an electrostatic accelerator were investigated, considering protons as an example. The losses of the proton beam on hydrogen and air-atom nuclei were evaluated. The losses diminish when the gas pressure in the tube is lowered, the extracting voltage of the ion source increases, the total voltage applied to the tube is raised, or the percentage of air in the tube is reduced. Especially heavy losses occur near the ion source. (D.C.W.)

1133 THE EXTRACTED 25 Gev/c PROTON BEAM FOR THE CERN NEUTRINO EXPERIMENT. R. Bertolotto, H. van Breugel, L. Caris, et al. (CERN, Geneva). p.523-35 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

The 25 Bev/c proton beam is extracted from the CERN proton synchrotron within a time interval of 2.1 μsec. For the production of a high flux of pions and kaons the beam is then guided toward an external target and in the target focused to ~1 mm^2 cross section. Results of preliminary beam studies are discussed and the apparatus used is described. (auth)

1134 MAGNETIC HORN AND NEUTRINO FLUX CALCULATIONS. M. Giesch, S. van der Meer, G. Pluym, and K. M. Vahlbruch (CERN, Geneva). p.536-45 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

The focusing behavior of the magnetic horn and some points of its construction are described. The shape of the inner conductor was modified since earlier publications. It consists now of a cylindrical part and two conical parts with different opening angles. Results of neutrino flux calculations are shown. Starting from the secondary particle flux at the target, the neutrino flux was computed in two stages: (a) calculation of pion and kaon flux vs angle and momentum behind the horn; and (b) calculation of neutrino flux vs momentum in the detectors. (A.G.W.)

1135 DEVICE FOR THE ACCELERATION OF CHARGED PARTICLES WITH TRAVELLING WAVE LINEAR ACCELERATOR. Wilson Shannon Geisler, Jr. (to High Voltage Engineering Corp.). German Patent 1,167,463. Apr. 9, 1964. Filed Mar. 21, 1957.

The exit of a klystron-type, high-frequency source is connected to the accelerator by a separate, hollow waveguide, which by-passes the channel through which the electrons are injected from the klystron into the accelerator. (Gmelin Inst.)

1136 ACCELERATOR FOR ION BUNCHES. Siegfried Klein and Jacques Pottier (to Commissariat à l'Energie Atomique). German Patent 1,168,580. Apr. 23, 1964. Priority date Nov. 25, 1958, France.

The accelerator consists of a pulsed ion source of high intensity which injects the ions into a tubular vacuum vessel, a plurality of accelerating electrodes located within the vacuum vessel, which are partially transparent for the ions, and a d-c source one pole of which is connected to the electrodes via resistances of high resistivity. The other pole of the d-c source is the reference potential. A feature of this accelerator is that although only a relatively small voltage source is necessary, the ions are accelerated independent of their velocities. (Gmelin Inst.).

Astrophysics and Cosmology

Refer also to abstracts 1067 and 1838.

1137 (AFCRL-64-572) THEORETICAL STUDIES IN ASTROPHYSICS. Final Report. Jack S. Goldstein (Brandeis Univ., Waltham, Mass.). June 30, 1964. Contract AF19(604)-7283. 46p. OTS.

Work is reported in brief on: physics of dense media, radiative transfer, and stellar associations. Preliminary descriptions of research on planetary nebula and globular clusters are reported and abstracted in two separate papers. (N.W.R.)

For abstracts of individual papers see: 1138 and 1139.

1138 (AFCRL-64-572(B1-19)) DYNAMIC EVOLUTION OF GLOBULAR CLUSTERS. Paul Easton (Brandeis Univ., Waltham, Mass.).

The average change in energy per unit time of a star in a globular cluster is theoretically studied. It is assumed that the change of the structure of the cluster is small in the period of an orbit of the test star for the derivation. The effects of polarization, perturbations, field star distribution, and stellar configuration are taken into account in this analysis. (N.W.R.)

1139 (AFCRL-64-572(A1-20)) PLANETARY NEBULAE. Murray Turoff (Brandeis Univ., Waltham, Mass.).

The problems involved in the theoretical treatment of planetary nebulae are usually broken down into three separate sections: radiative transfer (radiative intensities and fluxes), gas structure (ionization states, electron densities, and temperatures), and gas dynamics (density and velocity distributions in the nebulae). The successful analytical treatment of any of these problems depends upon results obtained from treatment of the other two. An attempt is being made to tie these three areas together and through the use of computer programs construct a unified model for planetary nebulae. (N.W.R.)

1140 ANNUAL REVIEW OF ASTRONOMY AND ASTROPHYSICS. VOLUME II. Leo Goldberg, ed. Ann. Rev. Astron. Astrophys., 2: 1-460(1964). Palo Alto, California, Annual Reviews, Inc. 1964.

Separate abstracts were prepared for six of the seventeen review articles included. The remaining papers deal with radio emission from Jupiter, RR Tyrae stars, star cluster dynamics, the moon, planetary nebulae, interplanetary debris, O associations near the sun, supernovas, atmospheres of magnetic and metallic-line stars, galaxy and star formation, and receivers for cosmic radio waves. (D.C.W.)

For abstracts of individual papers see: 1141, 1142, 1143, 1144, 1145, and 1146.

1141 ISOTOPE CHRONOLOGY OF METEORITES. J. Zaehringer (Max-Planck-Institut für Kernphysik, Heidelberg). Ann. Rev. Astron. Astrophys., 2: 121-48(1964).

The information on meteorite evolution that is available from isotopic determinations is reviewed, with consideration of specific determinations and of meteorite ages and evolution processes. 163 references. (D.C.W.)

1142 PHOTOSENSITIVE DETECTORS. William A. Baum (Mount Wilson and Palomar Observatories, Pasadena, Calif.). Ann. Rev. Astron. Astrophys., 2: 165-84(1964).

The properties of photosensitive detectors for astronomical observations are reviewed, including photographic emulsions, photoemissive cathodes, photoconductive and photovoltaic cells, photomultipliers, image tubes, and the human eye. (D.C.W.)

1143 NONTHERMAL RADIO FREQUENCY RADIATION FROM THE GALAXY. B. Y. Mills (Univ. of Sydney). Ann. Rev. Astron. Astrophys., 2: 185-212(1964).

The physical mechanisms of radio wave generation in the galaxy are briefly reviewed, together with modifications of their properties caused by interstellar matter. The results of observations are then outlined, and their interpretation is considered. 61 references. (D.C.W.)

1144 THE STRUCTURE OF THE SOLAR CHROMOSPHERE. B. E. J. Pagel (Royal Naval Coll., Greenwich, Eng.). Ann. Rev. Astron. Astrophys., 2: 267-96(1964).

Observations on the solar chromosphere are reviewed, together with models proposed for the chromosphere. The implications of optical, radio, and far ultraviolet observations, particularly, are considered. 126 references. (D.C.W.)

1145 SOME STATISTICAL PROPERTIES OF COMETS WITH PLASMA TAILS. D. Antrack, L. Biermann, and Rh. Luest (Max-Planck-Institut für Physik und Astrophysik, Munich). Ann. Rev. Astron. Astrophys., 2: 327-40(1964).

The results of observations pertaining to the value of comets with plasma tails as probes for the solar plasma are reviewed, including the distribution of the different tail types with respect to perihelion distance, relation of tail type to solar activity, persistence of plasma tails and their dependence on heliocentric latitude, and the angle between the plasma tail and sun-comet radius vector. Some well-observed comets are discussed. (D.C.W.)

1146 SOLAR FLARES. A. B. Severny (Crimean Astrophysical Observatory, Acedemy of Sciences, USSR). Ann. Rev. Astron. Astrophys., 2: 363-400(1964).

Observations on the radiation emission (particularly optical), structure, plasma motion, and distribution of solar flares are reviewed. Flare-associated phenomena including magnetic field variations are also considered, together with high-energy radiation from flares and theory for the origin of flares and solar cosmic rays. 153 references. (D.C.W.)

1147 GRAVITATIONAL INSTABILITY OF A NONHOMOGENEOUS PLASMA MEDIUM. L. M. Ozernoy. Astron. Zh., 41: 494-504(1964).

The gravitational instability of a slightly nonhomogeneous plasma medium in an optical-geometrical approximation is discussed, and the dispersion equation of the problem is derived. The conditions are determined under which there is an onset of gravitational instability in such a nonhomogeneous medium. The equation of gravitational instability of a nonhomogeneous medium; the gravitational instability in a homogeneous medium in the case of axially symmetric disturbances; magnetogravitational instability in the case of radial disturbances of a rotating nonhomogeneous axially symmetric system are studied. The described method, free from the shortcomings of the "local analysis" method, permits generalization in the case of a three-dimensional nonhomogeneity. In the presented variant it is possible to consider a number of problems in gravitational instability of a nonhomogeneous medium under a variety of physical conditions probably prevailing in an epoch of gravitational condensation (instability during rotation, presence of a magnetic field, flattening of the system). (auth)

1148 REMARKS ON THE THEORY OF TYPE-IV SOLAR BURSTS. A. Boehme (Astrophysikalische Observatoriums, Deutsche Akademie der Wissenschaften,

Potsdam, Ger.). Beitr. Plasmaphysik, 4: 137-48(1964). (In German)

Using some formulas of Takakura it is shown that the type IV bursts in the decimeter range may be interpreted by synchrotron radiation. Large helical angles of the electron orbits are necessary for the emission of a strong ordinary wave. Such helical angles are obtained if the magnetic field strength in the burst sources is assumed to be 200 to 300 gauss, and the helical angles are calculated from the adiabatic invariance of the magnetic moment $|\vec{\mu}| = (1/2)\ (mv_\perp^2/B)$ of the electron in its orbit. The opinion of Tanaka and Kakinuma, that there may be some relations between the storm continua and the type IV decimeter bursts, is discussed. It is shown that the storm continua and the type IV decimeter bursts are caused by different mechanisms. (auth)

1149 CONTINUOUS ABSORPTION BY THE CARBON NEGATIVE ION. V. P. Myerscough and M. R. C. McDowell (Royal Holloway Coll., Englefield Green, Eng.). Monthly Notices Roy. Astron. Soc., 128: 287-94 (May 1964).

The bound-free absorption coefficients for C^- are calculated, over a wide range of photon energies, in the dipole length and dipole velocity formulations, using Hartree-Fock bound state wave functions and central field continuum functions, taking into account orthogonalization and (a) polarization or (b) exchange. The final results obtained by method (b) show qualitative agreement with experimental results where available, except in the region very close to threshold. (auth)

1150 THE MAGNETIC FIELDS AND RADIO EMISSION OF GALAXIES. J. H. Piddington (Commonwealth Scientific and Industrial Research Organization, Sydney). Monthly Notices Roy. Astron. Soc., 128: 345-59(May 1964).

According to a unifying hypothesis of galactic formation, all galaxies are formed from intergalactic clouds imbedded in a weak ($\gtrsim 10^{-6}$ gauss), large scale ($\gtrsim$ 1 Mpc) magnetic field. Different classes of galaxy evolve depending on the angle between the rotational vector ω of the cloud and the field vector B. Flat disks of small radio emissivity form when ω and B are parallel. Spiral forms, including the Galaxy, form when ω and B are at a small angle. A theory of spirality and spiral arm formation is briefly developed; the same theory explains the observed distortion and thickening of the outer edge of our Galaxy. Radio galaxies are formed when ω and B are nearly perpendicular to one another. The magnetic field is then wound into a spiral form around the periphery of the galaxy which is compressed. The field expands explosively in the directions of the vectors $\pm\ \omega$ to form two separate blobs of radiating plasma. Radio stars such as Cygnus A would require more massive and faster rotating clouds than most radio galaxies. (auth)

1151 INTERPLANETARY SCINTILLATION OF SMALL DIAMETER RADIO SOURCES. A. Hewish, P. F. Scott, and D. Wills (Cambridge Univ., Eng.). Nature, 203: 1214-17(Sept. 19, 1964).

A systematic investigation was undertaken in which 3C 48 and other quasi-stellar sources were obserbed at 178 Mc. It was established that sources of this type exhibit random fluctuations of intensity with a time scale of the order of 1–2 sec while other sources do not. Normal ionospheric scintillation cannot explain these observations. A detailed analysis gives strong support to scintillation arising from irregularities situated in the interplanetary medium. Diffraction parameters, measurement of angular diameter, and the scale and motion of the interplanetary irregularities are discussed. (C.E.S.)

1152 ASSOCIATION OF THE GALACTIC RADIO SPUR WITH THE SCORPIO X-RAY SOURCE. M. J. S. Quigley and C. G. T. Haslam (Univ. of Manchester, Eng.). Nature, 203: 1272(Sept. 19, 1964).

It is shown that although the Scorpio x-ray source was perhaps the seat of a supernova explosion and the Galactic Radio Spur may be the expanding shell from such an event, it is unlikely that the two objects are associated in this way. (C.E.S.)

1153 THE NEUTRAL HYDROGEN FLUX IN THE SOLAR PLASMA FLOW. [PART] I. S.-I. Akasofu (Univ. of Alaska, College). Planetary Space Sci., 12: 905-13 (Oct. 1964).

It is shown that the photoionization by the extreme ultraviolet radiation of the sun is not likely to change seriously the initial degree of ionization of the chromospheric plasma during its passage to the earth. Thus, the plasma ejected from an active region of the sun can contain an appreciable amount of neutral hydrogen atoms. The development of the main phase of geomagnetic storms and the formation of the ring current belt by such an incompletely ionized solar plasma are discussed. (auth)

1154 A SIMPLE MODEL OF THE INTERPLANETARY MAGNETIC FIELD. David Stern (Goddard Space Flight Center, Greenbelt, Md.). Planetary Space Sci., 12: 961-71 (Oct. 1964).

A simple model of the interplanetary magnetic field is described and solved analytically. In this model, space is divided into three regions by two concentric spheres, conductivities (with one exception) are assumed to be isotropic and constant in each region, and flow velocities are regular and prescribed. The innermost region rotates rigidly around its center, the intermediate region contains a compressible fluid flowing radially outwards with constant velocity (an idealization of the solar wind), and the outermost region is at rest. The magnetic field originates in point sources at the origin and possibly also in a uniform field at infinity. Methods are developed for finding the field under these assumptions, in the general case and also in the limit when all conductivities are very high. As an example, the case in which the field's source is a point dipole, aligned with the axis of rotation, is solved in some detail. (auth)

1155 BASIC PARAMETERS OF BARYON CONFIGURATIONS. G. S. Saakyan and Yu. L. Vartanyan (Engineering Lab., Academy of Sciences, Armenian SSR). Soviet Astron. AJ (English Transl.), 8: 147-53(Sept.-Oct. 1964). Translated from Astron. Zh., 41: 193-200(Mar.-Apr. 1964).

The basic parameters of superdense celestial bodies are computed. The equation of state used was the equation of state for a real gas. In addition to the mass and the radius of the entire star, values cited include the mass and radii of the hyperon core (region of existence of hyperons), of the nucleon-nucleus layer (the "Aenp" and "Aen" phase), and the envelope ("Ae" phase). It was found that the bulk of the mass of configurations possessing a hyperon core is concentrated in that core. The radius and the total mass of the configurations undergo oscillatory variations as a function of the density at the center. The reason for this is the specific form of the equation of state in various density regions. The total number of baryons n and the gravitational mass defect were also computed. It is shown that for infinitely high densities the total mass M of a configuration is greater than nm, where m is the mass of a nucleon. Curves for the radial component of the metric tensor are also given in correspondence with various configurations. (auth)

1156 STRUCTURE AND FAR ULTRAVIOLET RADIATION OF THE UPPER STELLAR ATMOSPHERE. II. DISTRIBUTION OF ELECTRON CONCENTRATION AND TEMPERATURE. G. M. Nikolskii (Inst. of Terrestrial Magnetism, the Ionosphere, and Radio-Wave Propagation, Academy of Sciences, USSR). Soviet Astron. AJ (English Transl.), 8: 193-5(Sept.-Oct. 1964). Translated from Astron. Zh., 41: 251-4(Mar.-Apr. 1964).

T(h) and n(h) are computed for the transition layers of various types of stars, using the law $n^{2.5}\ T = \text{const}$ and the previously derived temperature dependence for the generalized emission measure. (auth)

1157 COLLISIONLESS HYDRODYNAMICS IN INERTIAL FRAMES OF REFERENCE. L. S. Marochnik (Inst. of Astrophysics, Academy of Sciences, Tadzhik

SSR). Soviet Astron. AJ (English Transl.), 8: 202-9 (Sept.-Oct. 1964). Translated from Astron. Zh., 41: 264-73(Mar.-Apr. 1964).

On the basis of the analogy between the Lorentz force and the Coriolis force in an inertial system, the equations of hydrodynamics are formulated here for an ensemble of noncolliding particles in such a system. The equations derived are similar to the equations of collisionless magnetohydrodynamics. The evolution of rotating objects (the Galaxy, galactic clusters, meteor streams, the Oort cometary cloud, etc.) can be discussed on the basis of these equations. By way of illustration of the method, the origin of the Schwarzschild velocity distribution in the Galaxy is treated. The entropy increase in the Galaxy, where close approaches between stars are virtually absent, may be due to nonlinear wave interaction. The free path of quasi-particles—wave packets—is far shorter than the true free path, and this means a shortening of the relaxation time to $T_r \approx 10^9$ years. The Maxwellian distribution of peculiar velocities resulting therefrom must be anisotropic, i.e., Schwarzschildian, while the velocity spread in the galactic plane σ_R, σ_θ is always greater than σ_z, the spread in the direction of the axis about which the Galaxy rotates. This is due to the pumping of energy ϵ in the plane perpendicular (to the angular velocity) on account of the energy of rotation. In mathematical terms, this is a corollary of the conservation of the adiabatic invariant $\epsilon_\perp/\Omega = \text{const}$. A possible nongravitational concentration of matter throughout the universe toward regions of locally high $\Omega(r, t)$ is pointed out. (auth)

1158 SOLAR CORONAL RADIATION SHORTWARD OF 10 Å. E. P. Fetisov (Lebedev Inst. of Physics, Moscow). Soviet Astron. AJ (English Transl.), 8: 231-3 (Sept.-Oct. 1964). Translated from Astron. Zh., 41: 299-301(Mar.-Apr. 1964).

The spectral radiation flux of the corona is computed theoretically for $\lambda < 10$ Å, taking line emission, radiative recombination, and bremsstrahlung into account. Continuous emission from heavy-ion recombination predominates. The theoretical flux is lower than the observed, showing that the corona is highly nonhomogeneous. (auth)

1159 THE DISTRIBUTION OF ORTHOHELIUM IN ACTIVE AND UNDISTURBED REGIONS OF THE SOLAR CORONA FROM OBSERVATIONS OF THE λ 10830 LINE. R. A. Gulyaev (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Academy of Sciences, USSR). Soviet Astron. AJ (English Transl.), 8: 243-50(Sept.-Oct. 1964). Translated from Astron. Zh., 41: 313-22 (Mar.-Apr. 1964).

During 1961–1962 a series of photographic observations of the He I line λ 10830 was carried out using the IZMIRAN tower telescope and an image converter. The center-limb variation of the equivalent width of the λ 10830 absorption line in active and undisturbed regions on the disc and the height dependence of the λ 10830 emission line intensity in the chromosphere are studied. The height dependence of orthohelium concentration in undisturbed regions near the pole and the equator, and also in active regions (above faculae) is obtained. (auth)

1160 EXCITATION AND IONIZATION OF HYDROGEN IN PROMINENCES. N. A. Yakovkin and M. Yu. Zeldina (Kiev State Univ.). Soviet Astron. AJ (English Transl.), 8: 262-7(Sept.-Oct. 1964). Translated from Astron. Zh., 41: 336-43 (Mar.-Apr. 1964).

It is shown that hydrogen atoms are ionized by solar radiation in the Balmer continuum, the temperature of which is 5700° (taking into account the Fraunhofer lines). From the equations of statistical equilibrium for many levels it is found that $n_e = 3.6 \times 10^{10}$. Radiation emission from prominences in the first lines of the Balmer series is due to resonance scattering of photospheric radiation, while that in the high-order lines is governed by the ionization-recombination mechanism. However, the observed intensities of the latter are in quantitative agreement with the intensities resulting from resonance scattering of solar radiation. (auth)

1161 SOME STATIONARY MOVEMENTS IN MAGNETIC GAS DYNAMICS. M. K. Zhekamukhov. Vestn. Mosk. Univ., Ser. III, Fiz. Astron., No. 3, 47-51(1964).

The investigation of the stationary movements of gravitating gaseous masses in a magnetic field is of interest to astrophysics, since many stars have strong magnetic fields and the material of which they are composed is a good conductor of electricity. Consequently, the magnetic field of a star exerts an influence on the flow of gaseous masses both inside and on the surface of the star. The flow of gas under the influence of gravitational and magnetic forces is considered, beginning with the rotation of a conducting gaseous sphere in a magnetic field. The motion of a charged particle at the surface of the Sun is studied, considering the magnetic field of the sun to be the field of a dipole whose axis nearly coincides with the axis of rotation of the sun. The equations derived indicate that under these conditions no individual charged particle would be able to escape from the surface of the Sun, no matter what its initial energy. Thus, either the Sun must not act as a dipole, or the particles must escape in the form of quasi-neutral ionic clouds. (auth)

1162 SOLAR SYSTEM ASTROPHYSICS. John C. Brandt and Paul W. Hodge. New York, McGraw-Hill Book Company, 1964. 465p. $12.50.

The physics of solar system phenomena are discussed. The topics include celestial mechanics, solar data and the solar interior, radiative transfer and the photosphere, the hydrogen convection zone, chromosphere, and corona, the solar magnetic field and solar activity, the solar spectrum, the interplanetary gas, comets, meteors, meteorites, asteroids, interplanetary dust, planetary interiors, planetary surfaces, atmosphere of the Jovian and terrestrial planets, and the moon and other satellites. (C.E.S.)

1163 COSMICAL ELECTRODYNAMICS. FUNDAMENTAL PRINCIPLES. Hannes Alfvén and Carl-Gunne Faelthammar. Second Edition. The International Series of Monographs on Physics. New York, Oxford University Press, 1963. 237p. $9.60.

The motion of charged particles in electric and magnetic fields, magnetohydrodynamics, and plasma physics are discussed for applications to the magnetohydrodynamic conditions in space around the earth. (C.E.S.)

1164 NONTHERMAL RADIATION FROM JUPITER IN THE DECAMETER WAVELENGTH RANGE. Alex G. Smith, T. D. Carr, and N. F. Six (Univ. of Florida, Gainesville and Universidad Chile, Santiago). p.25-36 of "Engineering Aspects of Magnetohydrodynamics." New York, Gordon and Breach Science Publishers, 1964.

Properties of the nonthermal radiation from Jupiter in the decameter wavelength range are discussed. Possible mechanisms of the Jovian r-f emission are considered. Polarization measurements indicate that the signals originated in a magnetoionic medium, and cyclotron radiation from solar electrons trapped in the Jovian magnetic field appears to be a promising mechanism to account for the energy. Alternative mechanisms include plasma oscillations and MHD waves generated by the impact of the solar plasma clouds. (C.E.S.)

Atomic Physics

Refer also to abstracts 959 and 1007.

1165 (COO-274-66) FUNDAMENTAL RESEARCH IN PHOTOEMISSION. Final Report. D[avid] W. Juenker (University of Notre Dame, Notre Dame, Ind.). [1964]. Contract AT(11-1)-274. 30p. Dep.(mn); $2.00(cy), 1(mn) OTS.

Findings, technical advances, and conclusions which seem to be the most significant of research in photoelectric emission conducted at University of Notre Dame are summarized. Information is included on: the effect of the surface barrier on photoelectric emission, optical influence on photoemission from bulk metal samples, opti-

cal properties of refractory metals, excitation and transport of electrons in vapor-deposited films, techniques for determining fundamental emitter properties, apparatus and laboratory methods, calibration measurements, and computer programs. (N.W.R.)

1166 (IFA-IS-M-35) DAS SCHIFFREMSSPEKTRUM. (The Schiff Bremsstrahlung Spectrum). D. Catana and C. Deberth (Academia R.P.R. Institutul de Fizica Atomica, Bucharest). 1964. 96p. Dep.(mn).

The differential bremsstrahlung cross section function of Schiff was integrated over scattered electron angles to obtain an expression for the distribution in energy and angle of the radiation from 5- to 25-Mev electrons in thin Ta targets. Screening was taken into account through the assumption of an atomic potential of the type $z_e/r \exp(-r/a)$. Results are tabulated. (R.E.U.)

1167 (ORNL-3676(p.3-5)) STUDIES OF THE MOVEMENT OF ENERGETIC ATOMS IN AND FROM SOLIDS. (Oak Ridge National Lab., Tenn.).

The effectiveness of channeling in reducing the predicted number of displacements in a cascade was studied by use of a formalism that allows the striking atom and the struck lattice atom to have different channeling probabilities following a collision. Abstracts are given for published papers on the theory of sputtering ejection patterns, computer studies of slowing down of energetic atoms in crystals, Monte Carlo range calculations for a Thomas–Fermi potential, and truncated potentials in theory of elastic atomic scattering. (R.E.U.)

1168 (ORNL-3676(p.6-7)) CALCULATIONS OF PROPERTIES OF COLOR CENTERS IN IONIC CRYSTALS. (Oak Ridge National Lab., Tenn.).

The excited states of the F center are investigated using both the method of linear combination of atomic orbitals and the vacancy-centered method to describe the wave functions. The absorption and emission spectra of the F center and their relation to each other are treated in an approximation which contains many features of an exact treatment. The singlet and triplet states of the M center are calculated in the Heitler-London method, using vacancy-centered wave functions. The theoretical basis of the Mollwo-Ivey relation for color centers is investigated. (auth)

1169 (ORNL-3676(p.74-8)) Ar^+ ION BOMBARDMENT OF METAL SURFACES. A. L. Southern (Oak Ridge National Lab., Tenn.).

MASS SPECTROMETRIC STUDIES OF SPUTTERED PARTICLES FROM COPPER MONOCRYSTALS. Abstract of conference paper to be published. SPUTTERING YIELDS AND EJECTION PATTERNS. Two new types of atom-ejection-pattern collectors were used. Ejection patterns and yield measurements were made for the three low-index planes of gold, and comparisons were made with earlier results on Cu and Al. Recent studies were interpreted in terms of focusing collision chains in Cd, Zn, and Mg. The sputtering yield is reported for the (0001) and $(10\bar{1}0)$ planes of Zn. (auth)

1170 (WIS-TCI-67) CALCULATED ELASTIC SCATTERING CROSS SECTIONS FOR THE Li^+–He SYSTEM. G. G. Weber and R. B. Bernstein (Wisconsin. Univ., Madison. Theoretical Chemistry Inst.). Oct. 6, 1964. Contract AT(11-1)-1328. 27p. (COO-1328-12) Dep.(mn); $2.00(cy), 1(mn) OTS.

Calculations of the energy dependence of the total (and differential) elastic scattering cross sections for the Li^+–He system were carried out for a number of assumed interaction potentials. All of these are known to yield good fits to existing mobility data, sensitive primarily to the long-range r^{-4} term in the potential. The results show that the total quantum cross sections (as well as the angular distributions) are quite sensitive to the potential also at short range (e.g., r < 4Å), even at low collision energies (E < 1 ev). In particular, the behavior of the extrema in the total cross sections offers a means of discrimination among the potentials. (auth)

1171 LASER-INDUCED EMISSION OF ELECTRONS, IONS, AND NEUTRALS FROM Ti AND Ti-D SURFACES. T. Y. Chang and C. K. Birdsall (Univ. of California, Berkeley). Appl. Phys. Letters, 5: 171-2(Nov. 1, 1964).

The plasma produced from deuterated titanium disks due to laser-induced emission is described. Three representative experiments were made: in one an unfocused, Q-switched laser on a Ti-D target was used; in a second a focused, non-Q-switched laser on a Ti target was used; and in another a focused, Q-switched laser on a Ti-D target was used. Retarding potential plots established electron temperatures of 7000°K for the first experiment and 16,600°K for the third experiment. Information about ion energy was obtained from time-of-flight measurements. It is shown that the ion time-of-flight is equal to the rise time of the ion current induced in an external circuit. (P.C.H.)

1172 SPECIFIC HEAT OF SPIN SYSTEM AT POSITIVE AND NEGATIVE ABSOLUTE TEMPERATURE. Vratislav Vysin and Josef Tillich (Palacky Univ., Olomouci, Czechoslovakia). Cesk. Casopis Fys., 14: 411-14(1964). (In Czech)

The paper shows the dependence of the specific heat of a spin system on the spin temperature for a constant magnetic field. A detailed calculation is performed for a system with equidistant energy levels. A physical interpretation is also given of the maxima and minima on the curves of the dependence of specific heat on –1/kT. (auth)

1173 NEW VISIBLE LASER LINES IN IONIZED XENON. Pierre Laures, Lucien Dana, and Charles Frapard (Centre de Recherches de la C. G. E., Marcoussis, France). Compt. Rend., 259: 745-7(July 27, 1964). (In French)

Two visible laser transitions were established. These rays, produced in a neon–xenon mixture by a pulse discharge, were identified in the spectrum of ionized xenon. The enrichment of the higher level seemed to be due to collisions of the second species between atoms of metastable neon and atoms of ionized xenon. (tr-auth)

1174 FURTHER INVESTIGATIONS ON "Z" DEPENDENCE OF RAYLEIGH SCATTERING OF GAMMA RAYS. V. M. Bhatnagar (Universita, Rome). Current Sci. (India), 33: 487-9(Aug. 20, 1964).

The Rayleigh-scattering cross section of 411-kev gamma rays is measured at 60 to 150° on targets of Pb, W, Sn, and Ag. These results are combined with those obtained at 662 and 280 kev, in order to find the dependence of the cross section on Z and scattering angle. (T.F.H.)

1175 CONFIGURATIONS $4f^26s$ AND $4f^26p$ IN DOUBLY IONIZED Pr. Nissan Spector (National Bureau of Standards, Washington, D. C.). J. Opt. Soc. Am., 54: 1359-62 (Nov. 1964).

Energy parameters are given for the $4f^26s$ and $4f^26p$ configurations of Pr^{2+}. An average agreement of better than 0.5% of the total configuration spread was obtained between the predicted and observed energy levels in both cases. Designations in (LS) J–j coupling are given. (auth)

1176 PRODUCTION OF NARROW BALMER SPECTRUM LINES IN AN ELECTRON-BOMBARDED ATOMIC HYDROGEN BEAM. John O. Stonner, Jr. (Princeton Univ., N. J.). J. Opt. Soc. Am., 54: 1377-9(Nov. 1964).

An apparatus is described that has produced and detected narrow Hβ and Hγ spectral lines in an electron-bombarded atomic hydrogen beam. Hydrogen atoms produced in an electrodeless 50-Mc/sec discharge in wet hydrogen, diffused through a slit in the discharge tube wall to form a beam in a vacuum chamber. An electron gun bombarded the atomic beam along an axis perpendicular to the beam and optical axes; light produced in the decay of atoms excited by the bombardment was analyzed by a pressure-scanned Fabry-Perot interferometer and detected by a cooled photomultiplier. The output pulses from the photomultiplier were amplified and then stored as counts in a 400-channel analyzer. Linewidths characteristic of a

source at about 33°K were obtained; however, the signals were so small and the line shapes sufficiently uncertain that no precise wavelength measurements could be made. (auth)

1177 NEW RESULTS ON POLARIZATION OF SLOW ELECTRONS (0.5 TO 1.5 kev) BY ELASTIC SCATTERING ON FREE Hg ATOMS. H. Deichsel and E. Reichert (Universitat, Mainz). Naturwissenschaften, 51: 432(1964). (In German)

The dependence of the polarization degree of elastically scattered electrons was measured at electron energies from 0.5 to 1.5 kev as a function of the scattering angle. Hg atoms were the scattering medium. The experimental results agreed well with the theoretical prediction that within small scattering angle ranges the polarization degree changes from large positive values to large negative values. This change occurred at scattering angles between 97.5 and 107.5°. (J.S.R.)

1178 A SEMIEMPIRICAL METHOD FOR DETERMINING THE ELECTROSTATIC POTENTIAL OF THE MOLECULAR ELECTRON SHELL AT THE ATOMIC NUCLEI. I. THEORY OF THE METHOD FOR DIATOMIC MOLECULES. T. K. Rebane. Opt. Spectry. (USSR) (English Transl.), 17: 1-3(July 1964). Translated from Optika i Spektroskopiya, 17: 3-7(July 1964).

A previously proposed method for finding the values of the electrostatic potential of the electron shell near nuclei in free atoms is extended to the case of atomic nuclei in molecules. The method is based on interpolation of the energies of isoelectronic ions and on the application of the generalized Gelman–Feynman theorem. (C.E.S.)

1179 MANY-BODY PERTURBATION THEORY APPLIED TO ATOMS. Hugh P. Kelly (Univ. of California, San Diego, La Jolla, Calif.). Phys. Rev., 136: B896-? (Nov. 9, 1964).

Many-body perturbation theory as formulated by Brueckner and Goldstone is applied to atoms to obtain corrections to Hartree-Fock wave functions and energies. Calculations are made using a complete set of single-particle Hartree-Fock wave functions, which includes both the continuum and an infinite number of bound states. It is shown how one may readily perform the sums over an infinite number of bound excited states. In order to demonstrate the usefulness of many-body perturbation theory in atomic problems, calculations are made for a wide variety of properties of the neutral beryllium atom. The calculated 2s-2s correlation energy is −0.0436 atomic unit for l = 1 excitations. The calculated dipole and quadrupole polarizabilities are 6.93×10^{-24} cm^3 and 14.1×10^{-40} cm^5, respectively. The calculated dipole and quadrupole shielding factors are 0.972 and 0.75. Results are given for oscillator strengths, photoionization cross sections, and the Thomas-Reiche-Kuhn sum rule, which is 4.14 as compared with 4.00, the theoretical value. (auth)

1180 RARE-GAS AND HYDROGEN MOLECULE ELECTRONIC STATES, NONCROSSING RULE, AND RECOMBINATION OF ELECTRONS WITH RARE-GAS AND HYDROGEN IONS. Robert S. Mulliken (Univ. of Chicago). Phys. Rev., 136: A962-5(Nov. 16, 1964).

Recent experimental work on helium jets has indicated that excited atoms result usually from collisional-radiative electron capture by atom ions ($A^+ + 2e \rightarrow A^* + e$; etc.) rather than by dissociative recombination by molecule ions ($A_2^+ + e \rightarrow A^* + A$), while for the heavier rare gases, the latter process is apparently relatively important. It is shown that the theoretically expected forms of the potential curves of excited He_2 and other rare-gas molecules make dissociative recombination improbable for He_2^+ but more probable for the other rare-gas diatomic ions. Available spectroscopic data and theoretical considerations make it fairly sure that many of the familiar excited states of He_2 have high maxima in their potential curves, but that no pure repulsion curves, except the one for two normal He atoms, exist below the energy of $He^+ + He$. Besides the stable states with stable He_2^+ core ($1\sigma_g^2 1\sigma_u$, $^2\Sigma_u^+$) plus a Rydberg electron, there must be others with a core ($1\sigma_g 1\sigma_u^2$, $^2\Sigma_g^+$) which per se is unstable but which on addition of an electron in a sufficiently strongly bound Rydberg orbital is stable; consideration of these states makes possible a reasonable explanation of the Hornbeck-Molnar effect in helium. Statements analogous to those about potential curves and electron recombination in helium are applicable also to a large extent for hydrogen. (auth)

1181 FIELD THEORETICAL EFFECTS IN X-RAY SPECTRA. T. V. Krishnan and Amar Nath Nigam (Atomic Energy Establishment, Trombay, India). Proc. Indian Acad. Sci., Sect. A, 60: 75-84(Aug. 1964).

The $L_I - L_{II}$ screening doublet separation in the relativistic approximation up to Z^{20} was compared with that obtained experimentally by the transitions $M_{IV}\ L_{II}$ ($L\beta_1$) and $M_{IV}\ L_I$ ($L\beta_{10}$). The experimental and theoretical values deviate considerably. If terms up to Z^4 are retained, an apparently close fit with the experimental values is obtained. It is shown that such a fit disappears on applying the field theoretical corrections and this stresses the need of retaining the terms up to Z^{20}. The justification of neglecting the still higher powers of Z lies in the smallness of their magnitude when compared to the experimental errors. The field theoretical corrections modify the relativistic curve that contains terms up to Z^{20} in such a way that one again gets a good fit with the experimental values. This shows how the various field theoretical corrections and the contributions from relativistic terms with powers of Z greater than four compensate each other. (auth)

1182 OPERATOR METHODS IN SHELL THEORY. Hiroshi Watanabe (Univ. of Michigan, Ann Arbor). Progr. Theoret. Phys. (Kyoto), 32: 106-25(July 1964).

A shell theory is developed in terms of electron creation and annihilation operators. A seniority scheme is defined through pair creation and pair annihilation operators, which are defined on the concept of Kramers's pair states. Matrix relations for single-electron tensor operators are derived through commutation relations between the operator and the pair operators. Matrix relations are also found for a two-electron scalar operator. A complementary transformation relating the matrix elements of the electron operators between complementary states is defined. The complementary transformation leads to theorems for half-filled shells. (auth)

1183 STRUCTURE OF THE SPECTRA OF DISORDERED SYSTEMS. I. FUNDAMENTAL THEOREMS. Junichi Hori (Hokkaido Univ., Sapporo) and Hirotsugu Matsuda. Progr. Theoret. Phys. (Kyoto), 32: 183-9(Aug. 1964).

Two theorems are presented that play a fundamental role in discussing the spectra of disordered systems. The first theorem is valid for any mixed lattice described by a set of a number of 2 × 2 non-singular transfer-matrices with real traces, arranged regularly or randomly. It states that, if a value of frequency or energy lies in one of the spectral gaps for every constituent regular lattice, and if the fixed points of the transformations induced by these matrices are so arranged that there exists a trapping region, the density of frequency or energy spectrum of the mixed lattice vanishes at this frequency or energy value. For some special forms of the transfer-matrices, which often appear in physical problems, the latter condition may be stated in terms of a simple notion of "phase," so that we get the second theorem. Various theorems of Saxon-Hutner type are to be deduced from these theorems, according to the nature, or the manner of description, of individual systems. (auth)

1184 THE MEASUREMENT OF OSCILLATOR STRENGTHS IN ATOMIC SPECTRA. E. W. Foster (London Univ.). Rept. Progr. Phys., 27: 469-551(1964).

Methods of measurement primarily are reviewed. Formulas relating radiation intensities and radiation constants—transition probabilities, lifetimes, and oscillator strengths—are set out in a simple way to coordinate the discussion. Examples are selected to illustrate the more important methods recently used for measurement of radiation constants for discrete and continuous spectra.

Interesting reduction procedures are outlined. Tables illustrate the consistency of the results obtained by the application of different methods to measure the same constant. 300 references. (auth)

1185 ALKALI "TRIODE" ION AND FAST NEUTRAL SOURCE. K. Rubin, P. Dittner, and B. Bederson (New York Univ., New York). Rev. Sci. Instr., 35: 1720-1 (Dec. 1964).

A device designed somewhat like a conventional triode, which serves as an ion source and a monoenergetic fast-neutral source for alkali elements (particularly K, Rb, and Cs), is described. Several versions of the device are described. (T.F.H.)

1186 PROBABILITY OF IONIZATION OF HYDROGEN BY ELECTRON IMPACT. V. A. Bronshten (Moscow Planetarium). Soviet Astron. AJ (English Transl.), 8: 326-7(Sept.-Oct. 1964). Translated from Astron. Zh., 41: 416-18(Mar.-Apr. 1964).

A comparison is made of empirical expressions for the ionization cross sections and the formulas for the ionization coefficient of hydrogen by electron impact. (auth)

1187 ADIABATIC APPROXIMATION IN THE COLLISION THEORY. G. V. Dubrovskii. Vestn. Leningr. Univ., No. 10, Ser. Fiz. i Khim., No. 2, 5-10(1964). (In Russian).

A general solution of the vector equation describing the interaction of n levels was derived in the adiabatic approximation. This solution allows the use of the phase integral method for deriving the probabilities of non-adiabatic transitions, if zeros of ω are far enough from one another. As an example a problem of the pseudocrossing of two levels is considered, and the Landau–Zener formula is derived. (auth)

1188 SOLUTION OF THE SELF-CONSISTENT FIELD EQUATIONS FOR ATOMS BY THE APPLICATION OF BESM-2M. V. F. Brattsev. Vestn. Leningr. Univ., No. 10, Ser. Fiz. i Khim., No. 2, 24-30(1964). (In Russian)

The method of computing self-consistent field equations is given. By this program ground and some excited states of light atoms (Z = 2 to 18) were calculated. The results for He are given as an example. (auth)

1189 PHYSICS OF ATOMIC COLLISIONS. J. B. Hasted. Butterworths Advanced Physics Series. Monographs on Ionization and Electrical Discharges in Gases. Washington, D. C., Butterworths, 1964. 544p. $26.00.

The classical and quantum theoretical methods for calculating collision cross sections are summarized, and the principles and limitations of experimental techniques for studying atomic processes are outlined. Experimental and theoretical aspects of electron elastic scattering in gases, electron excitation and ionization of atoms, positive ion recombination, electron attachment and detachment, radiation emission and absorption, elastic scattering of atomic particles, charge transfer and ion-atom interchange, and collisions of excited atoms are surveyed. (D.C.W.)

1190 SPECTROMETRY OF ENERGY LOSSES OF ELECTRONS TRANSMITTED THROUGH SOLIDS. O. Klemperer (London Univ.). p.127-43 of "Physical Processes in Radiation Biology." New York, Academic Press, 1964.

Spectrometry of electrons transmitted through solids is reviewed in relation to multiple scattering, discovery of characteristic energy losses, identification of the origin of the characteristic energy losses, characteristic energy losses in compounds and alloys, and small angle resolution. (H.M.G.)

1191 EXCITED STATES PRODUCED BY LOW-ENERGY ELECTRONS. Aron Kuppermann and L. M. Raff (Univ. of Illinois, Urbana). p.161-81 of "Physical Processes in Radiation Biology." New York, Academic Press, 1964.

The results described indicate that low-energy electron-impact spectroscopy can be a very useful tool to help elucidate the electronic structure of molecules, especially their low lying optically forbidden electronic states. Not only can such states be easily located, but it seems to be possible to distinguish between spin-forbidden and symmetry-forbidden transitions by observing the variation of peak intensities with incident electron beam energy. Since the spectrometer described can be operated at 350°C, and since a vapor pressure of 10^{-4} mm Hg is sufficient for an impact spectrum to be obtained, a large number of molecules can be studied by the technique. The results also show that spin-forbidden excitations are easily detected in our instrument even when incident electron beam energies as much as 50 ev above the transition energies are used. (auth)

Cosmic Radiation

Refer also to abstract 1425.

1192 (MIT-2098-77) COSMIC GAMMA RAYS — EXPERIMENTAL. W. L. Kraushaar (Massachusetts Inst. of Tech., Cambridge. Lab. for Nuclear Science). [1964]. Contract AT(30-1)-2098. 11p. (CONF-760-1) Dep.(mn); $1.00(cy), 1(mn) OTS.

From Symposium on Astronomy from Space Vehicles, Liege, Aug. 1964.

As yet no experiment, satellite-borne, balloon-borne, or earth-based has provided compelling evidence for more than upper limits to the intensity of cosmic gamma rays of more than a few Mev energy. Even these upper limits have been useful in blocking in some of the large scale properties of energetic particles in interstellar and intergalactic space. Nevertheless, the smallest upper limit set on the intensity of diffuse gamma rays, 3×10^{-4} cm^{-2} sec^{-1} sterad^{-1} (from the satellite experiment in Explorer XI), is a factor of about 20 above the intensity prediction that can be made with rather good confidence for gamma rays made in cosmic ray collisions with interstellar atomic hydrogen. (auth)

1193 (PAN-498/VI) FOUR MOMENTUM TRANSFER BETWEEN GROUPS OF PARTICLES ON COSMIC-RAY JETS OF VERY HIGH ENERGIES. J. Babecki, T. Coghen, M. Miesowicz, and K. Niu (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). Feb. 1964. 13p. Dep.

An analysis of the four-momentum transfer between two groups of particles was made for 75 primary jets fulfilling the conditions $5 \leq n_s \leq 20$, $N_h \leq 5$, $\gamma_c \geq 23$. For 6 asymmetric jets without tracks in the diffuse cone, the four-momentum transfer between the nucleons and the group of secondary particles was also analyzed. It was found that events with a distinct double-maximum structure and low multiplicity, as well as asymmetric events are characterized by appreciably smaller four-momentum transfers as compared with others. It is not, however, possible to state unambiguously whether the four-momentum transfer for these jets is really of the order of a few pion masses at the most. This is the case if the transverse momenta of the groups of produced particles and the baryons do not exceed considerably the value of a few pion masses, and if small or no excitation of the baryons is considered. (auth)

1194 (PAN-507/VI) HISTOGRAMS OF THE REGISTRATION OF THE PENETRATING COMPONENT OF E.A.S. WITH ACCOUNT FOR SECONDARY INTERACTIONS IN THE ABSORBER. J. Hibner, J. Gawin, J. Wdowczyk, and A. Zawadzki (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). Mar. 1964. 26p. Dep.

Secondary interactions of nucleons and muons in a thick absorber caused deformation of the histogram of registration of the penetrating component. Instead of counts having a hypergeometric distribution, a tendency is observed for the counts to be in groupings. The general method and

several special examples of histograms of actual counts being transformed into the form which they would have if there were no secondary multiplications of particles in the absorber are presented. The histograms so corrected represent the undisturbed state of hodoscope registrations and can be used in work where the registrations of the penetrating component are usually affected by quite serious deformations. It seems essential to take corrections into account in an analysis of experimental results since the registrations are carried out on the surface of the earth and the nucleon component of E.A.S. plays a considerable role (especially close to the axis of the shower, e.g., at an average distance of 15 m these corrections may come to more than 40%). (auth)

1195 (UCRL-11204) PRODUCTION OF COSMIC RAYS BY BETATRON ACCELERATION AND STRUCTURE OF EXTRAGALACTIC RADIO SOURCES. Nicola Cabibbo (California, Univ., Berkeley. Lawrence Radiation Lab.). Feb. 10, 1964. Contract W-7405-eng-48. 11p. (CONF-452-58). Dep.(mn); $1.00(cy), 1(mn) OTS.

From American Physical Society, Washington, D. C., Apr. 1964.

The possible role of the betatron effect as a mechanism for the acceleration of cosmic particles to relativistic energies is discussed. It is proposed that the mechanism can be extremely efficient in a region where the magnetic field is zero or very small compared with time-dependent magnetic fields is nearly regions. A possible model for extragalactic radio sources is developed; increasing dipole plus a constant field. (R.E.U.)

1196 SECONDARY ELECTRON COMPONENT OF COSMIC RAYS AND THE SPECTRUM OF GENERAL GALACTIC RADIO EMISSION. V. L. Ginzburg. Astron. Zh., 41: 430-45(1964).

The energy spectrum and spatial distribution of secondary electrons forming at the time of nuclear interactions of cosmic rays in the interstellar gas are calculated. The motion of electrons in interstellar space is considered as isotropic diffusion. Synchrotron, Compton, and ionization losses of electron energy are taken into account. The intensity of the synchrotron radiation of secondary electrons is also computed. This intensity is appreciably less (by at least two orders of magnitude for wavelengths $\lambda \lesssim 1$ m) than the observed value. It therefore follows that the general galactic radioemission is generated by primary electrons, which enter interstellar space from certain sources (in a stationary model, from the envelopes of supernovae). There is a discussion of certain requirements that such sources must satisfy, and also an analysis of problems associated with a nonstationary galactic model (a model in which there are explosions at the center of the galaxy). The spectrum of generation of secondary electrons, the distribution of secondary electrons in the galaxy, the origin of relativistic electrons in the galaxy, and the electron component of cosmic rays at the earth are discussed. (auth)

1197 GEOGRAPHIC DISTRIBUTION OF SOLAR DIURNAL VARIATION IN THE NEUTRON COMPONENT OF COSMIC RAYS. E. S. Glokova. Geomagnetizm i Aeronomiya, 4: 275-84(1964).

The geographic distribution of amplitude and phase characteristics of the diurnal variation in the neutron component of cosmic rays for the period of the International Geophysical Year and the International Solar Year was investigated, using data from a worldwide network of stations. The geographic distribution of the diurnal variations is more complex than would follow from the theory of a single dipole. Changes with time of diurnal and semidiurnal variations are alike (changes in the amplitudes of harmonics 1 and 2 are worldwide), permitting representation of the mechanism by a single model. Data from stations at Berkeley, Lomnitse, Yakutsk, and Invercargill, however, are not representative for studying the overall pattern of diurnal variation. For these stations at least three out of four characteristics differ sharply. For the stations at London, Leeds, Hermanus, Makarere, and Sidney, the actual errors in diurnal variation exceed the errors due to statistical fluctuation. If the European maximum is disregarded, it is found that the amplitude distribution of diurnal variation in the neutron component corresponds to a spectrum of anisotropy having the form $\delta D(\epsilon)/D(\epsilon) = a$. There is some anomaly, however, in the amplitude of the first harmonic at the European stations, and a longitude effect is detected in the amplitude of the second harmonic near the equator. The anisotropy spectrum does not contradict the possible development of anisotropy as a consequence of solar wind. (TCO)

1198 DIURNAL ANISOTROPY OF COSMIC RAYS AND VARIATIONS IN THE GEOMAGNETIC FIELD. O. I. Inozemtseva. Geomagnetizm i Aeronomiya, 4: 285-9(1964).

At least two causes have been found for anisotropy of cosmic rays during magnetic storms leading to anomalous properties of the diurnal variation. One cause is the modulation of galactic cosmic particles by corpuscular streams of the sun. The other lies in influence of the geomagnetic field on the trajectories of cosmic particles. The disturbed diurnal variations in the neutron component of cosmic rays for 11 February 1958 were compared with the S_d variation of the geomagnetic field. It was found that in the period considered the S_d variation in the geomagnetic field could not be completely determined by the disturbed diurnal variation of cosmic rays. Statistical analysis of counter-telescope data in Moscow for 1960 and of geomagnetic-field data at the equator confirms the conclusion that, along with the local source of diurnal variation in cosmic rays during changes in the geomagnetic field exceeding 100 gammas, the influence of the distant source greatly increases the modulation of cosmic rays by solar corpuscular streams. (TCO)

1199 THE COSMIC RAY ANISOTROPY. David Stern (Goddard Space Flight Center, Greenbelt, Md.). Planetary Space Sci., 12: 973-8(Oct. 1964).

Three different explanations for the observed cosmic ray anisotropy are investigated. The possibility that the anisotropy is due to the existence of trapped orbits in the interplanetary field is explored by analyzing the motion of charged particles in a stretched dipole field. It is found that an anisotropy is possible, but only when several unlikely conditions are met. Two other theories of the anisotropy, ascribing it either to a sunward flux density gradient or to the Compton-Getting effect, are then discussed. It is shown that in general both effects occur together; for conservative fields they cancel each other and no anisotropy occurs, as might indeed be expected from Liouville's theorem. Consequently, any gradient of cosmic ray flux density which may be observed in interplanetary space is not necessarily connected with the observed anisotopy. (auth)

1200 INVESTIGATION OF THE SPATIAL DISTRIBUTION OF MU-MESONS IN EXTENSIVE ATMOSPHERIC SHOWERS AT A DEPTH OF 200 METERS (WATER EQUIVALENT). T. T. Barnaveli, M. F. Bibilashvilli, A. K. Dzhavrishvili, G. A. Grubelashvili, R. E. Kazarov, R. V. Kuridze, and I. V. Khaldeeva. Soobshch. Akad. Nauk Gruz. SSR, 35: 59-66(1964).

The spatial distribution of the penetrating component of extensive air showers was studied. The density of the meson (μ) flux was measured to a distance of 80 to 100 m from the shower axis. The total number of penetrating particles with a minimum energy of 40 Bev and their contribution to the energy balance of the shower were calculated. The mean shower particle number was 6×10^5. Densities are tabulated, and an expression is given for the distribution. The results are compared with similar observations. (D.C.W.)

1201 ENERGY SPECTRUM OF HIGH-ENERGY NUCLEAR-ACTIVE COMPONENT OF COSMIC RAYS. Indralal Chakraborty (Bose Inst., Calcutta). Trans. Bose Res. Inst. (Calcutta), 26: 11-25(Mar. 1963).

An account is given of an experimental study of the energy spectrum of the nuclear-active (n-a) component of

cosmic rays in the energy region 12 to 450 Bev by using a penetrating-shower detector consisting of an ionization chamber and a system of G-M counters. The energy of n-a particles was measured by estimating the fraction of energy dissipated in the photon-electron cascades arising from the decay of π^0 mesons produced in the nuclear interaction of n-a particles. It is found that within the investigated energy interval the energy spectrum has a single slope, which is nearly equal to the slope of the primary cosmic ray spectrum. This result indicates that the mode of propagation of the nuclear-active component is the same throughout the atmosphere and that the degree of inelasticity in the high-energy nucleon-nucleon collisions does not change appreciably with energy. (auth)

1202 COSMIC RAYS. Bruno Rossi. McGraw-Hill Paperbacks in Physics. New York, McGraw-Hill Book Co., 1964. 278p. $5.95.

A historical review of the discovery and analysis of cosmic radiation is given. The properties and origin of cosmic radiation are also considered. (C.E.S.)

Criticality Studies

1203 (K-1619) THE ELEMENTS OF NEUTRON INTERACTING ARRAYS. PART I. UNREFLECTED, HOMOGENEOUS ARRAYS OF URANIUM METAL AND URANIUM SOLUTION MATERIALS. C. E. Newlon (Oak Ridge Gaseous Diffusion Plant, Tenn.). Oct. 13, 1964. Contract W-7405-eng-26. 42p. Dep.; $2.00(cy), 1(mn) OTS.

Consideration was given specifically to arrays whose units are individually safe for diffusion plant operations and to the derivation of optimum spacing criteria for these units. Part I of the report covers that portion of the work concerned with homogeneous arrays of interacting uranium solution units, in air, and also includes results for arrays of high-density uranium metal units. From the mass-volume relations developed from the calculations, it appears that, for equal volume arrays, the minimum critical U-235 mass will occur at an intermediate U-235 enrichment appreciably lower than the 93% level at which the single unit minimum critical mass is normally found. (auth)

Direct Energy Conversion

Refer also to abstracts 577, 863, 1710, and 1711.

1204 (AD-601256) EMITTER-COLLECTOR PAIRS FOR GAS PLASMA THERMIONIC ENERGY CONVERSION. Final Technical Report, December 1962–December 1963. Report No. 420. R. Engdahl (Consolidated Controls Corp., Bethel, Conn.). Contract Nonr-4023(00). 64p. (CCC-HD-6827). $1.75(OTS).

It was demonstrated that thermionic energy conversion can be accomplished in a converter consisting of emitter, collector, and auxiliary electrode operating in an inert gas. Twelve different rare earth emitters were evaluated for zero field vacuum emission characteristics. Using W and Gd_{2O3} as prime constituents, four different emitter fabrication methods were evaluated. Zero field pulse emission from Gd_{2O3} in a tungsten helix was measured at 9.6 amps/sq cm at 1450°C. A collector work function of 1.0 ev was attained by a nickel collector coated with 200 A of Al_{2O3} and evaporated barium. A collector work function of 0.9 ev was attained by a nickel collector coated cataphoretically with 20 microns of Gd_{2O3} and evaporated barium. A method for measuring collector work functions by electron absorption was developed and proven. (auth)

1205 (AD-605365) LONG LIFE CLOSED LOOP MHD RESEARCH AND DEVELOPMENT UNIT TENTH PROGRESS REPORT. Quarterly Technical Progress Report No. 10, June 1, 1964–August 31, 1964. R. L. Hundstad, F. A. Holmes, and M. G. Fey (Westinghouse Electric Corp., Pittsburgh). Aug. 31, 1964. 21p. $2.00(OTS).

The third test of the closed loop is described. The goal of gas conductivity in the generator of one mho per meter was met and exceeded, achieving a value approximately one hundred times better than the previous test. Details of the test are presented along with planned improvements for the next test. (auth)

1206 (AERE-R-4715) THERMIONIC CONVERTERS USING CYLINDRICAL REFRACTORY METAL EMITTERS. K. F. Bainton (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Sept. 1964. 24p. Dep.; $0.70 (BIS), 3s. 6d.(HMSO).

The construction and operation of four converters are described. Two converters using tantalum emitters operated satisfactorily but temperatures of the order of 2500°K were necessary to obtain power densities of 6 watts/cm^2. Closer spaced diodes using molybdenum emitters were not initially successful due to internal short circuiting, this was caused partly by evaporated films but mainly by liquid cesium. One of these diodes was modified and yielded 2.6 watts/cm^2 at 1610°K. (auth)

1207 (ANL-6870) PERFORMANCE CHARACTERISTICS OF A LIQUID METAL MHD GENERATOR. Michael Petrick and Kung-You Lee (Argonne National Lab., Ill.). July 1964. Contract W-31-109-eng-38. 70p. Dep.; $3.00 (cy), 2(mn) OTS.

An experimental study was made of the performance characteristics of a liquid metal MHD generator utilizing single-phase NaK and two-phase NaK–N_2 fluids. The purpose of this study was to compare the generator performance with theory for single-phase flow and to determine the effects of the introduction of the gaseous phase on the generator output and efficiency. Data were taken over the following parameter ranges: fluid velocity, 1.11 to 10.94 ft/sec; mixture quality, 0 to 0.0156; volumetric void fraction, 0 to 0.66. The variation of the Hartmann number and the magnetic Reynolds number (based on the height of the channel) corresponding to these parameter ranges was 88 to 178, and 0.035 to 0.35, respectively. An extension was made of Hartmann's flow analysis to a generator duct that takes into account end losses and power dissipation in the duct wall. The agreement between the theory and the data was good. The end loss correction factors used were those proposed by Sutton. Comparison of the data with the theory tended to validate the use of these factors. The open-circuit and closed-circuit voltage, current, and power output could be computed accurately, but the measured pressure drop deviated substantially from the predicted values. From the NaK–N_2 two-phase flow tests, an empirical relation was developed for the two-phase conductivity as a function of the void volume fraction. The relation is $\sigma_{TP}/\sigma = \exp(-3.8\alpha)$. The implications of two-phase conductivity on MHD generator performance are discussed. (auth)

1208 (JÜL-170-PC) ELEKTROCHEMISCHE WÄRME-KONVERTER. (Electrochemical Heat Converters). G. Grueneberg (Kernforschungsanlage, Jülich, Germany). Apr. 1964. 30p. Dep.(mn).

Several of the physical methods for direct conversion of heat to electricity, such as thermoelectric and thermionic methods, are already used in technical devices. The utilization of the Hall effect on streaming plasma of MHD converters is still the object of intensive research. In addition to various other physical methods, the electrochemical possibilities of heat conversion were investigated. The electrochemical methods may be divided into four groups: (1) the electrochemical system is subject to a periodic temperature change; (2) the reaction product of a galvanic element is regenerated outside the electrochemical system by thermal decomposition to the reactive components; (3) the aqueous electrolyte of a concentration cell is regenerated outside the electrochemical system by thermal fractionation; and (4) the electrodes of an electrochemical system are at different temperatures. These methods were illustrated with concrete examples and compared with the physical methods of heat conversion. (tr-auth)

1209 (MND-2812-5) RESEARCH AND DEVELOPMENT ON BARIUM VAPOR-FILLED THERMIONIC PLASMA ENERGY CONVERTERS. Quarterly Progress Report No. 5, March 1–June 30, 1963. (Martin-Marietta Corp. Aerospace Div., Baltimore). Aug. 15, 1963. Contract AT(30-1)-2933. 43p. Dep.(mn); $2.00(cy), 1(mn) OTS.

The program consists of an experimental and analytical investigation of the performance of barium vapor-filled thermionic energy conversion devices and an investigation of factors underlying the performance of the converters. Device S11.2, a flat-plate device with continuously variable interelectrode spacing, having a tantalum emitter and niobium collector, was tested with barium vapor. The device was tested in the emitter temperature range of 1900 to 2100°K, the barium temperature range of 900 to 1230°K, collector temperature range of 1075 to 1250°K and at interelectrode spacing from 0.003 to 0.050". The device was tested a total of 260 hours, including 140 hours with barium vapor. The device is still under test. (auth)

1210 EXPERIMENTAL INVESTIGATIONS OF THE MAGNETIC-TRIODE TYPE THERMIONIC ENERGY CONVERTER. M. Zgorzelski (Technical Univ., Warsaw). Bull. Acad. Polon. Sci., Ser. Sci. Tech., 12: No. 6, 449-55(1964).

A description of the magnetic-triode thermionic cell is given. The performance characteristics of the cell are calculated theoretically. The output characteristics are calculated and measured as functions of magnetic field and electric potential. (T.F.H.)

1211 NATURE OF SPONTANEOUS OSCILLATIONS IN A CESIUM DIODE ENERGY CONVERTER. W. T. Norris (Massachusetts Inst. of Tech., Cambridge). J. Appl. Phys., 35: 3260-8(Nov. 1964).

The spontaneous oscillations observed in plasma diodes are investigated using a collisionless model. A possible instability in the steady-state conditions is predicted, which arises because the electrons can redistribute their charge more rapidly than the ions. (D.C.W.)

1212 MHD WITH LIQUID METAL. H. E. Weber and C. H. Marston (General Electric Co., King of Prussia, Penna.). Mech. Eng., 86: 34-7(Aug. 1964).

An MHD device is discussed in which liquid metal at about 2000°F travels in a circle through a radial magnetic field, the liquid vortex being propelled by vapor of the same metal. Two configurations are considered. (D.C.W.)

1213 MEASUREMENT OF PLASMA VELOCITY IN MHD GENERATOR CHANNEL. Szymon Suckewer and Zdzislaw Celiński (Inst. of Nuclear Research, Warsaw). Nukleonika, 9: 771-8(1964).

The results obtained to date from an experimental program that was undertaken to evaluate the use of ion plasmoids introduced into the stream in order to measure its velocity are presented. The experimental arrangement consisted of an arc plasma generator discharging argon into a constant area channel for MHD-power generation study, special electrodes for transverse arc discharge and several photomultipliers coupled with oscilloscopes. The relation between measured gas velocities and the mass flow through the plasma generator is presented together with the results obtained from the electromotive force induced in the MHD-channel. (auth)

1214 MAGNETOHYDRODYNAMICS AND GAS DISCHARGES. J. D. Cobine (General Electric Research Lab., Schenectady, N. Y.). p.169-85 of "Engineering Aspects of Magnetohydrodynamics." New York, Gordon and Breach Science Publishers, 1964.

The characteristics of various gas discharges are discussed, and possible or probable phenomena in the MHD discharges are inferred from similarities. Space charge phenomena, principle sustained discharges, conductivity, and surface phenomena are considered. A bibliography of 43 references is included. (C.E.S.)

1215 HISTORY OF THE K AND H GENERATOR AND CONCLUSIONS DRAWN FROM THE EXPERIMENTAL RESULTS. Bela Karlovitz (Combustion and Explosives Research, Inc., Pittsburgh) and Dénes Halász. p.187-203 of "Engineering Aspects of Magnetohydrodynamics." New York, Gordon and Breach Science Publishers, 1964.

The theory, design calculations, and experimental work of the K and H generator are discussed. In the generator scheme that was developed, positive ions are used to transmit the electrical forces to the neutral gas. The positive space charge is neutralized by free electrons that are permitted to move transversely through crossed electric and magnetic fields, whereby the electrical force acting on the electrons is balanced by the Lorentz force. This system may be considered as a semi-permeable membrane that permits the passage of ions and neutral molecules, but blocks the passage of free electrons. On excitation of the magnetic field, electrons arriving at the generator are retarded and positive ions emerge at the exit. The voltage generated by these space charge clouds is parallel to, but opposing, the gas flow velocity. (C.E.S.)

1216 SOME ASPECTS OF MHD POWER PLANT ECONOMICS. J. J. William Brown (General Electric Co., Schenectady, N. Y.). p.223-41 of "Engineering Aspects of Magnetohydrodynamics." New York, Gordon and Breach Science Publishers, 1964.

Results from a study initiated to investigate the economic feasibility of a large MHD steam-turbine combined cycle power plant of a design requiring the minimum practicable projection of current theoretical work are discussed. The plant design, MHD generator design, generator materials, plasma conductivity, magnetic field strength, plasma velocity, generator loading factor, combustion air preheater, the cycle used for plant design, the electrical design, and the plant cost and performance estimates are considered. (C.E.S.)

1217 SOME ELECTRICAL MEASUREMENTS ON MHD CHANNELS. L. P. Harris and G. E. Moore (General Electric Research Lab., Schenectady, N. Y.). p.259-77 of "Engineering Aspects of Magnetohydrodynamics." New York, Gordon and Breach Science Publishers, 1964.

Measurements obtained during a program of experimentation intended to provide experience in the operation of combustion flows of the type that might prove useful in power generation are reported. Characteristics of the flow and the channel, results with the Faraday generator configuration, and results with the Hall generator configuration are discussed. (C.E.S.)

1218 THE CONDUCTANCE OF SEEDED COMBUSTION PRODUCTS IN MHD CHANNEL FLOW. M. S. Jones, Jr., V. H. Blackman, and C. N. McKinnon (MHD Research, Inc., Newport Beach, Calif.). p.279-89 of "Engineering Aspects of Magnetohydrodynamics." New York, Gordon and Breach Science Publishers, 1964.

Some of the problems that arise in measurements to determine the conductivity of seeded combustion product gases from the electric conductance of a MHD flow channel are shown. The factors that arise during these measurements include a number of mechanisms that can be important in the operation of larger scale power devices. (C.E.S.)

1219 A NON-EQUILIBRIUM ALTERNATING CURRENT MAGNETOGASDYNAMIC LINEAR INDUCTION GENERATOR. Robert L. Carter and Richard A. Laubenstein (Atomics International, Canoga Park, Calif.). p.291-327 of "Engineering Aspects of Magnetohydrodynamics." New York, Gordon and Breach Science Publishers, 1964.

Through the employment of a selected gaseous mixture as a working fluid in a closed cycle system, a low temperature system employing a linear induction magnetogasdynamic generator may be used to obtain alternating current electric power. The possibility of using such a system in conjunction with a nuclear heat source arises as peak working gas temperatures drop to values which are achievable in controlled fission reactors. Experiments

underway suggest that the gaseous conductivity required for efficient MGD power generation may be obtained in selected gaseous mixtures by the expenditure of a fraction of the power generated to sustain non-equilibrium ionization. Efficiency of the system for sustainment of the requisite ionization is enhanced in the electrodeless alternating current generator by the removal of the electrodes which act as severe recombination sinks. (auth)

1220 FRINGING EFFECTS IN AN AC MHD GENERATOR. J. B. Fanucci (Radio Corp. of America, Moorestown, N. J.), L. J. Kijewski, N. Ness, and J. E. McCune. p.329-43 of "Engineering Aspects of Magnetohydrodynamics." New York, Gordon and Breach Science Publishers, 1964.

A solution for the first order electrodynamic fringing field in an a-c MHD generator is presented for an arbitrarily prescribed current distribution in the excitor coils. The solution is given in terms of a contour integral for the magnetic stream function. A particular example is solved in detail. The results indicate that the e-folding distances for fringing are greater at the entrance than at an exit. The local impedance indicates that power is being pumped into the plasma near the entrance and the exit. This reflects in the generator performance as a loss due to increased ohmic heating of the plasma. The Fourier integral method presented may be employed to solve the fringing problem when shading coils are utilized. (auth)

1221 A MAGNETOPLASMADYNAMIC POWER GENERATION EXPERIMENT USING HELIUM–CESIUM. B. C. Lindley (C. A. Parsons and Co. Ltd., Newcastle-upon-Tyne, Eng.). p.345-61 of "Engineering Aspects of Magnetohydrodynamics." New York, Gordon and Breach Science Publishers, 1964.

The main magnetoplasmadynamic power generation experiment is in an advanced stage of construction, and a comprehensive investigation of the thermal equilibrium and non-equilibrium properties of inert gas–alkali metal vapor plasmas was initiated. (auth)

1222 A STUDY OF MAGNETOHYDRODYNAMIC PARAMETRIC GENERATORS. H. H. Woodson, G. L. Wilson, and A. T. Lewis (Massachusetts Inst. of Tech., Cambridge). p.363-79 of "Engineering Aspects of Magnetohydrodynamics." New York, Gordon and Breach Science Publishers, 1964.

An analysis is presented for an induction-type MHD generator. The parameters of a simplified equivalent circuit are derived, and the conditions for self-excitation are given in terms of these parameters. An experiment is described which shows that the circuit parameters may be obtained approximately from measurements in the sinusoidal steady state on a stationary geometry and that the values obtained allow a fairly accurate prediction of the actual generator behavior. This allows the circuit parameters to be related to the magnetic Reynolds number, R_m, of the gas flow and to the generator geometry, and allows the determination of a minimum R_m for self-excitation and of the efficiency of the generator. (C.E.S.)

1223 EXPERIMENTS WITH A TRANSIENT DC CROSSED-FIELD ACCELERATOR AT HIGH POWER LEVELS. William T. Hogan (Massachusetts Inst. of Tech., Cambridge). p.479-505 of "Engineering Aspects of Magnetohydrodynamics." New York, Gordon and Breach Science Publishers, 1964.

Experiments with a viscously contained accelerator having an applied current and magnetic field perpendicular to each other and to the flow are discussed. The electric currents in the presence of the magnetic field produce a force ($J \times B$) which accelerates the gas. The specific impulse of this device appears to lie between that of the arc jet and ion beam devices and it seems capable of extending the efficient operation of the arc jet engine from 1500 to 5000 sec. (C.E.S.)

1224 DISCUSSION OF A SELF-POWERED MHD CONTROL FOR RE-ENTRY VEHICLE APPLICATION. C. du P. Donaldson (Aeronautical Research Associates of Princeton, Princeton, N. J.) and M. J. Brunner. p.559-77 of "Engineering Aspects of Magnetohydrodynamics." New York, Gordon and Breach Science Publishers, 1964.

Self-powered MHD control, which consists of obtaining a sufficient interaction force in an MHD channel to create a torque about the center of gravity of a vehicle so that its altitude can be controlled, is discussed. The actual flight path is thus controlled by the aerodynamic forces which act on the vehicle at angle of attack. The operation of an MHD channel depends on the electric conductivity of the plasma between a pair of electrodes operating within a properly oriented magnetic field. The magnetic field can be maintained by an electromagnet located beneath the surface of the vehicle away from the plasma and powered by the plasma itself. A number of problems associated with the design of the MHD control system are considered. (C.E.S.)

Elementary Particles and Radiations

Refer also to abstracts 1406 and 1448.

1225 (JINR-E-1817) THE REAL PART OF THE ELASTIC p-p SCATTERING AMPLITUDE IN THE RANGE 2-10 Gev. L. Kirillova, V. Nikitin, V. Sviridov, et al. (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of High Energy). 1964. 5p. Dep.(mn).

The energy dependence of the real part of the scattering amplitude is obtained in investigating elastic p-p scattering at 2 to 10 Bev. (auth)

1226 (JINR-P-1731) NEUPRUGIE p-p VZAIMODEISTVIYA S MALOI PEREDACHEI IMPUL'SA. (Inelastic p-p Interactions With Small Momentum Transfer). S. A. Azimov, B. P. Bannik, T. Vishki, U. G. Gulyamov, Yingseb To, B. G. Rakhimbaev, and L. I. Chernova (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of High Energy). 1964. 9p. Dep.(mn)

The inelastic p-p interactions at the primary proton energies of 2.26 and 9 Bev were studied using nuclear emulsions. The energy distributions of slow protons were obtained. In processing the experimental data, the relative yields of reactions involving the formation of one and two isobars are estimated qualitatively from an isobar model. (auth)

1227 (JINR-P-1741) ϕ-MEZON I NIZKOENERGETICHESKIE VZAIMODEISTVIYOS ELEMENTARNYKH CHASTITS. (The ϕ-Meson and Low-Energy Interactions of Elementary Particles). L. D. Solov'ev and A. V. Shchelkachev (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1964. 12p. Dep.(mn).

It is shown that the account of ρ, ω, and ϕ resonances in nucleon form factors leads to good agreement with experiment. The kaon form factors are treated and the ϕ-meson-nucleon coupling constant is estimated. (auth)

1228 (JINR-P-1742) DVYGORBYI VID IMPUL'SNOGO SPEKTRA PROTONOV OTDACNI V NEUPRUGIKH π^--p VZAIMODEISTVIYAKH PRI 7 Gev I ODNOMEZONNOE PRIBLIZHENIE. (Two-Hump Shape of the Momentum Spectrum of the Recoil Protons in Inelastic π^--p Interactions at 7 Gev and One-Meson Approximation). P. Smrzh (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1964. 8p. Dep.(mn).

The inelastic π^--p interactions at 7 Bev are described with the aid of the one-meson model. It is shown that under the assumption about the definite energy of the $\pi\pi$ interaction cross section it is possible to obtain the momentum spectrum of the recoil protons with two peaks (this spectrum should be close to the experimental one). It is important that the existence of the high-energy resonances is not necessarily required to be assumed; agreement with experiment can be obtained by taking into account the nucleon form factor and making use of the value for the $\pi\pi$ interaction cross section. (auth)

1229 (JINR-P-1780) KOMPLEKSNYE MOMENTY I VZAIMODEISTVIE PRI VYSOKIKH ENERGIYAKH. (Complex Angular Momenta and Interactions at High Energies). V. N. Gribov) (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). 1964. 34p. (CONF-550-63) Dep.(mn).

From the International Conference on High-Energy Physics, Dubna, USSR, Aug. 1964.

An analysis was made of the complex angular momenta and interactions at high energies, considering relatively inelastic processes in the j-plane approximation and amplitude peculiarities in the complex plane. The asymptotics of elastic and inelastic processes, Regge poles, and perturbation theory are discussed. (R.V.J.)

1230 (JINR-P-1791) SLABYE YZAIMODEISTVIYA S UCHASTIEM OBYCHNYKH CHASTITS. (Weak Interactions of Nonstrange Particles (Experimental)). A. I. Mukhin (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). 1964. 31p. (CONF-550-79). Dep.(mn).

From The International Conference on High-Energy Physics, Dubna, USSR, Aug. 1964.

Experimental studies were made of weak interactions between nonstrange particles in order to verify the universality of weak interactions. The magnitude of the "weak charge" in β-decay was considered to be the unit of interaction force. An analysis was made of various possible combinations of weak processes considering conservation of the vector current, μ and π decay, μ capture by nuclei, and nonconservation of parity in strong interactions. 52 references are included. (R.V.J.)

1231 (LA-DC-6491) ON THE NUMERICAL ANALYSIS OF PHOTON TRANSPORT. Burton Wendroff (Los Alamos Scientific Lab., N. Mex.). [nd]. Contract W-7405-eng-36. 7p. (CONF-755-1). Dep.(mn); $1.00(cy), 1(mn) OTS.

From Opacity Conference, Albuquerque, N. Mex., Sept. 1964.

Numerical solutions of photon transport equations where no simplifying assumptions can be made concerning optical depth are discussed for stationary materials. (R.E.U.)

1232 (LNF-64/26) MUON COUPLING PARAMETERS FROM RADIATIVE MUON ABSORPTION IN LIQUID HYDROGEN. Note No. 246. E. Borchi and R. Gatto (Italy. Comitato Nazionale per l'Energia Nucleare. Laboratori Nazionali, Frascati). June 10, 1964. 7p. Dep.(mn).

Radiative muon absorption in liquid hydrogen including a possible term in the axial current with second class behavior under G-transformation is discussed. (R.E.U.)

1233 (MIT-2098-79) MULTIPLE PION AND STRANGE PARTICLE PRODUCTION IN γ-RAY-PROTON REACTIONS BETWEEN 0.5-4.8 Bev. Y. Eisenberg (Massachusetts Inst. of Tech., Cambridge); M. Widgoff (Brown Univ., Providence); A. E. Brenner (Harvard Univ., Cambridge, Mass.); L. Guerriero (Padua. Universita); G. E. Fischer, et al. (Cambridge Electron Accelerator, Mass.). Oct. 23, 1964. Contract AT(30-1)-2098. 7p. (CONF-550-87). Dep.(mn); $1.00(cy), 1(mn) OTS.

From the International Conference on High-Energy Physics, Dubna, USSR, Aug. 1964.

Approximately 120,000 bubble chamber pictures were analyzed following exposition to a well-collimated and hardened 4.8-Bev bremsstrahlung beam at the Cambridge Electron Accelerator. The separation between various classes of events was achieved by using the CERN kinematical fitting program GRIND; 588 two-pion, 311 three-pion, 52 strange particle, and 43 five-prong events were observed. Cross sections are summarized. Studies were made of N^*_{33} production, meson (ρ^0) photoproduction, and SU(3) symmetry predictions. (R.E.U.)

1234 (PAN-347) ELASTIC SCATTERING OF 24.7-Mev ALPHA PARTICLES. A. Budzanowski, K. Grotowski, S. Micek, H. Niewodniczanski, J. Sliz, A. Strzalkowski, and H. Wojciechowski (Polish Academy of Sciences. Inst. of Nuclear Physics, Krakow). May 1964. 48p. Dep.

The differential cross sections for the elastic scattering of 24.7-Mev alpha particles on O, Mg, Al, Si, Ca, Mn, Co, Ni, Cu, Ge, Zr, Ag, In, Sn, Hf, W, Au, Bi, and U nuclei were measured by means of a semiconductor detector in a wide range of angles. The behavior of the angular distribution curves for different mass numbers is discussed. (auth)

1235 (PPAD-521-F) A SPARK CHAMBER EXPERIMENT ON THE $\Delta S = \Delta Q$ RULE IN $K^0_{\ell 3}$ DECAYS (thesis). Richard B. Wattson (Princeton-Pennsylvania Accelerator, Princeton, N. J.). July 10, 1964. Contract [AT(30-1)-2137]. 97p. Dep.(mn); $3.00(cy), 2(mn) OTS.

A determination of the validity of the $\Delta S = \Delta Q$ selection rule for $K^0_{\ell 3}$ decay was made by the use of a spark chamber technique. The rule seems to be valid within a wide confidence interval set by the statistics of a small number of events. The ratio Γ_1/Γ_2 of the $K^0_{\ell 3}$ rates is equal to 0.2 from 10 $K^0_{\ell 3}$ events spread throughout the $30 \times 30 \times 60$ cm^3 spark chamber. The violation parameter x is equal to -0.4. The events are more clearly identified than corresponding ones in a bubble chamber version of this experiment because of the use of a Cherenkov counter for electron triggering. Kinematic analysis is also used to separate out unwanted backgrounds and insure correct event identification. (auth)

1236 (UCRL-11622) SIMPLE CALCULATIONS OF RESONANCES IN BARYON-MESON TWO-PARTICLE CHANNELS. Shu-yuan Chu (California. Univ., Berkeley. Lawrence Radiation Lab.). Aug. 19, 1964. Contract W-7405-eng-48. 12p. Dep.; $1.00(cy), 1(mn) OTS.

The matrix formulation of the N/D method is applied in the static model to the case of n-coupled two-particle channels containing one baryon and one pseudoscalar meson. The N function is approximated by a single pole at the same position for all matrix elements, with residues given by exact SU_3 symmetry. The mass splitting of the $P_{\frac{1}{2}}$ baryon decuplet is studied, as well as the effect of the $\kappa\Sigma$ channel on the position of the 3-3 resonance and the πN 3-3 phase shift. (auth)

1237 IZOTOPICHESKII SPIN — IZOSPINOVYI ANALIZ SIL'NYKH VZAIMODEISTVII. (Isotopic Spin. Isospin Analysis of Strong Interactions). V. I. Rus'kin. Alma-Ata. Izdatel'stvo Akademii Nauk Kazakhskoi SSR, 1964. 85p.

Strong interaction processes are analyzed on the basis of isospin conservation. Experimental data are developed, and isospin formalism in quantum field theory is discussed. (R.V.J.)

1238 STUDIES OF MANY-CHANNEL SCATTERING. II. CONNECTION BETWEEN TOTAL AND PARTIAL WIDTHS. Hans A. Weidenmueller (Universität, Heidelberg). Ann. Phys. (N. Y.), 29: 378-82(Oct. 5, 1964).

The results of a previous paper on many-channel scattering are used to investigate the formula which expresses the total width of a resonance as a sum of the partial widths of the open channels. If a resonance is defined by a pole of the S-matrix, it is shown that this formula is valid only in the limit of arbitrarily sharp resonances and only if the sum of the absolute values of the partial widths of the open channels (these widths are in general complex) is considered. (auth)

1239 HIGH-ENERGY SCATTERING IN THE UNITARY SYMMETRY MODEL. Michiji Konuma (Scuola Normale Superiore, Pisa, Italy) and Yukio Tomozawa. Ann. Phys. (N. Y.), 29: 391-400(Oct. 5, 1964).

Assuming that the conjecture of Okun and Pomeranchuk is valid, the relations are derived between elastic scattering amplitudes at high energy in the unitary symmetry models in which perturbation due to a symmetry-breaking interaction is taken into account to any order. Results are also given for three cases in which the following assumptions on high energy scattering are included: universality of the ratio of elastic to total cross sections, addition of the Pomeranchuk theorem to the previous assumption, or factorizability of total cross sections. It is shown that, at high energy, the equality of the total cross section of π-N scattering and that of K-N scattering, which holds in the

case of complete symmetry, is also valid in first-order perturbation of the symmetry-breaking interaction under the last two assumptions. (auth)

1240 HIGH-ENERGY PHYSICS OF THE WORKING GROUP FOR HIGH-ENERGY PHYSICS. H. Rollnik (Universität, Bonn). Atompraxis, 10: 444-7(Sept.-Oct. 1964). (In German)

The structure and the work possibilities of the high-energy physics group was reported. A survey on the most important studies made was given. These consist of measurements of photoreactions in the 500 Mev range and evaluation of cloud chamber measurements in the energy range of 4 Bev. (tr-auth)

1241 CONTRIBUTION TO THE THEORETICAL STUDY OF THE NUCLEON-NUCLEON INTERACTION. Michel Lacombe. Cahiers Phys., 18: 93-136(Mar. 1964). (In French)

The formulas relating the results of different experiments on nucleon-nucleon scattering to the coefficients of the M matrix introduced by Wolfenstein and Ashkin are established and discussed. The formalism of the M matrix is generalized to the case where the target is polarized. The possibilities offered by the polarized targets are then discussed. The parameters of the deuteron and of dephasing in nucleon-nucleon scattering are calculated beginning with the Cottingham and Vinh Mau potential. (J.S.R.)

1242 CROSSING MATRICES FOR HELICITY AMPLITUDES, APPLICATION TO CROSSED CHANNEL PARTIAL-WAVE ANALYSIS, AND REGGEIZATION. Ivan J. Muzinich (Univ. of Washington, Seattle). J. Math. Phys. (N. Y.), 5: 1481-90(Nov. 1964).

The crossing relations of two-body scattering amplitudes for reactions involving particles with spin are derived for the helicity amplitudes of Jacob and Wick. From the crossing relations, the differential cross section and polarization of the direct channel are related to the analytic continuation of the crossed channel helicity amplitude. The differential cross section is then expressed in terms of the crossed channel partial waves, and rules are given for treating the exchange of fixed angular momentum poles and Regge poles for two-body processes involving particles with higher spin. (auth)

1243 ASYMPTOTIC BEHAVIOR OF FEYNMAN INTEGRALS WITH SPIN. J. C. Polkinghorne (Cambridge Univ., Eng.). J. Math. Phys. (N. Y.), 5: 1491-8(Nov. 1964).

Some general features are investigated of the dependence of the asymptotic behavior of Feynman integrals upon factors in the numerator of the integrand resulting from particles with spin. These results are used to analyze the high-energy behavior of ladder diagrams for spin-$\frac{1}{2}$ nucleons interacting with neutral vector mesons. The leading contribution is shown to consist of terms corresponding to a reggeized nucleon together with certain other terms. The expected cancellation of these other terms by terms associated with a well-defined class of crossed diagrams is verified in detail for the sixth-order case. Other significant diagrams, different from the ladders and their associated crossed diagrams, are investigated, and it is shown that they only provide higher-order corrections to the trajectory of the reggeized nucleon. (auth)

1244 POSSIBLE RELATIONSHIP BETWEEN ELECTRIC CHARGE AND DUAL CHARGE. Elihu Lubkin (Brown Univ., Providence). J. Math. Phys. (N. Y.), 5: 1603-6(Nov. 1964).

Electric charge has no direct meaning for strong interactions, yet is involved in the octet model in such a way that the size of the elementary unit of electric charge becomes tied to the topology of the group of strong interaction symmetries. This tie may indicate a relation of electric charge to another kind of charge gotten directly from topology of the group. (auth)

1245 SCATTERING WAVEFUNCTIONS FOR A DIRAC PARTICLE IN A CENTRAL POTENTIAL. D. M. Fradkin, C. L. Hammer, and T. A. Weber (Ames Lab., Ames, Iowa). J. Math. Phys. (N. Y.), 5: 1645-51(Nov. 1964). (IS-919)

The scattering wavefunction for a Dirac particle in a central potential is written in terms of a matrix acting on a plane-wave spinor whose momentum direction $\hat{p}$ and polarization direction are the assigned directions for the asymptotic incident plane wave. The matrix involves four functions, independent of polarization direction, which multiply the matrices 1, $\alpha \cdot (\hat{p} - \hat{r})$, $\alpha \cdot (\hat{p} + \hat{r})$, and $\hat{p} \cdot \hat{r} \cdot \sigma$. Differential relations for these four functions are directly obtained, and asymptotic relations are given. In particular, the function multiplying $\alpha \cdot (\hat{p} + \hat{r})$ is asymptotically zero, so the potential scattering formulation is identical with that given previously for the Coulomb potential. The scattering wavefunction is a solution of the general differential relations subject to appropriate boundary conditions. For the Coulomb potential, these differential relations simplify, and an iterative solution is developed based on a Green's function technique with the Sommerfeld-Maue approximation as the zero-order solution. (auth)

1246 COMPLEX LORENTZ GROUP WITH A REAL METRIC: GROUP STRUCTURE. A. O. Barut (Univ. of Colorado, Boulder and National Bureau of Standards, Boulder, Colo.). J. Math. Phys. (N. Y.), 5: 1652-6(Nov. 1964).

In the attempts to connect the Lorentz group and the internal symmetry group of fundamental particles, a 16-parameter connected, noncompact group of rank 4 is studied in detail. The subgroup structure, Lie algebra and its complex extension (which is A_3 in Cartan's notation), little groups, the inhomogeneous groups, and the group invariants are discussed. (auth)

1247 SPACE, TIME, AND ELEMENTARY PARTICLES. Henry P. Stapp (Univ. of California, Berkeley). J. Sci. Ind. Res. (India), 23: 281-4(July 1964).

The developments in elementary particle physics that challenge the ancient ideas about the nature of space, time, and elementary particles are discussed. The early concepts of space, the wave concept of light, relativistic concepts, quantum mechanical ideas, particle and field concepts, quantum field theory, and S-matrix theory are considered. (C.E.S.)

1248 ON FIRST ORDER ORDINARY DIFFERENTIAL EQUATIONS ARISING IN DIFFUSION PROBLEMS. I. I. Kolodner (Univ. of New Mexico, Albuquerque), J. Lehner, and G. M. Wing. J. Soc. Ind. Appl. Math., 12: 249-69(June 1964).

General equations of the form $dx/dt = g(t,x)$, $t > 0$, $x(0) = C \geq 0$, where g is a decreasing function of both x and t and is positive for $x = 0$ are investigated. The existence, uniqueness, and domain of existence of the solution of this equation are considered. The general shape of the solution is studied, and questions of extrema and concavity are settled. (C.E.S.)

1249 THE ADIABATIC INVARIANTS OF THE MOVEMENT OF A CHARGED PARTICLE IN A STATIONARY, NON-UNIFORM MAGNETIC FIELD. V. D. Pletnev and G. A. Skuridin. Kosmich. Issled., 1: 387-402(1963).

The movement of a charged particle in a non-uniform magnetic field is considered on the basis of a study of the preservation of all adiabatic invariants that correspond to the spatial symmetry of the magnetic system; that is, an analysis is made of the conditions for the conservation of the first, second, and third motion invariants of a charged particle in a spatial magnetic system. Since this movement of a particle in a magnetic field is not, strictly speaking, conditionally periodic, in principle there may arise a divergence of the adiabatic approximation, connected with the indivisibility of the variables employed in the Hamilton-Jacobi equation. Finally, there is a discussion of estimation problems with respect to the degrees of accuracy in the preservation of the second and third invariants in a stationary magnetic field. (OTS)

1250 DISCOVERY OF THE Ω HYPERON. A. G. Tenner (Universiteit, Amsterdam). Ned. Tijdschr. Natuurk., 30: 211-13(May 1964). (In Dutch)

The detection of a Ω hyperon with strangeness −3, in a hydrogen bubble chamber irradiated with K^- mesons at 5 Bev/c, was announced. The possible reaction path is diagrammed, and a hypothesis on the course of the reaction, based on kinematic calculations, is given. (J.S.R.)

1251 MEASUREMENTS OF THE WOLFENSTEIN R AND R′ PARAMETERS IN PROTON-PROTON SCATTERING AT 98 Mev. O. N. Jarvis (Atomic Energy Research Establishment, Harwell, Berks, Eng.), B. Rose, G. F. Fox, and G. H. Eaton. Nucl. Phys., 61: 194-208(Jan. 1965).

Measurements were made of the Wolfenstein R parameter at c.m. angles 31.3, 41.6, 51.7, 61.9 and 72.0 degrees. The values obtained were -0.22 ± 0.11, -0.40 ± 0.10, -0.39 ± 0.09, -0.12 ± 0.13 and -0.18 ± 0.20, respectively. Measurements were also made of the R′ parameter at c. m. angles 31.6, 41.9, 52.0 and 62.6 degrees. The values obtained for R′ were 0.59 ± 0.23, 0.66 ± 0.18, 0.70 ± 0.18, and 0.52 ± 0.30 respectively. The R′ values were deduced from asymmetry measurements which were proportional to the combination ($R \cos \theta_s + R' \sin \theta_s$) of the R and R′ parameters, where the spin precession angle θ_s was approximately 45°, so that it has been necessary to use the above values for R in order to obtain these R′ values. (auth)

1252 DEFINITION OF $\mathscr{P}$, $\mathscr{C}$, $\mathscr{T}$ OPERATORS FOR THE RELATIVISTIC-ROTATOR MODEL AND THE BRONZAN-LOW SYMMETRY. M. Flato, G. Rideau, and J. P. Vigier (Institut Henri Poincaré, Paris). Nucl. Phys., 61: 250-6(Jan. 1965).

A relativistic-rotator model for the internal structure of elementary particles has been developed by de Broglie, Bohm, Takabayasi, Halbwachs, Hillion, and Vigier. According to this theory, the internal-group symmetry of elementary particles is $\mathscr{P} \times \mathscr{C}$, where $\mathscr{P}$ stands for the proper homogeneous Lorentz group. By methods of group theory the operators, $\mathscr{P}$, $\mathscr{C}$, and $\mathscr{T}$ for this group are defined, and then for the group representations. From these definitions the Bronzan-Low symmetry for strong interactions is derived, on the basis of a Yukawa-type four-dimensional strong-interaction model. (auth)

1253 INFLUENCE OF STRONG MAGNETIC FIELD ON THE DIRECTIONAL DISTRIBUTION OF PHOTONS FROM TWO-QUANTUM ANNIHILATION IN TITANIUM. Bronislaw Rozenfeld and Jan Wesolowski (Boleslaw Bierut Univ., Wroclaw, Poland). Nukleonika, 9: 427-37 (1964).

The directional distributions of gamma-ray pairs from two-quantum positron annihilation in titanium were observed with and without the external 22 kGs magnetic field. The comparison of the distribution curves showed that in the presence of the magnetic field a relative increase of the rate of two-quantum annihilations, or a narrow component, appeared at small angular departures of quanta from collinearity. The appearance of a narrow component in a strong magnetic field can be explained by the ortho-para conversion of positronium, arising from the Zeeman effect. Assuming such a mechanism of the increase of the rate of two-quantum events at small angles, the results of the measurements are interpreted as an experimental evidence of positronium formation in titanium. (auth)

1254 ON THE FIELD EQUATIONS. I. CANONICAL FORM. II. PERTURBATION THEORY. III. NONPERTURBATIVE APPROXIMATIONS. IV. NONRENORMALIZABLE INTERACTIONS. V. THE TWO-PARTICLE APPROXIMATION. VI. STABILITY AND COMPOSITE PROPERTIES OF PARTICLES. J. G. Taylor (Inst. for Advanced Study, Princeton, N. Y. and New York Univ., New York). Nuovo Cimento (1) 1: No. 3, Suppl., 857-1035 (1963).

Formalism for the field theory approach to elementary particles is presented. (C.E.S.)

1255 VELOCITY-DEPENDENCE IN THE n-p INTERACTION AND THE DEUTERON FORM-FACTOR. R. K. Bhaduri (Oxford Univ.). Phys. Letters, 12: 346-7(Oct. 15, 1964).

A comparison is made of the deuteron form factors derived by two methods: that using a velocity-dependent two-nucleon potential having no hard core; and that using hard-core nucleon form factors derived from electron-scattering experiments. It is concluded that there is no evidence against velocity-dependent potentials of the type studied. (T.F.H.)

1256 ELASTIC SCATTERING CROSS SECTION OF Λ^0 HYPERONS ON NUCLEONS. P. Bellière (Ecole Polytechnique, Paris), J. L. Gomez, A. Lloret, A. Rousset, K. Myklebost, and J. M. Olsen. Phys. Letters, 12: 350-1(Oct. 15, 1964).

The cross section for elastic scattering of Λ^0 hyperons by protons is measured as (25 ± 4) mb. The value is based on a study of 86 events at Λ^0 momenta of 0.5 to 1.2 Bev/c. The ratio of the cross section for scattering by protons to that for scattering by neutrons is found to have the value 0.9 ± 0.5, in agreement with charge symmetry. (T.F.H.)

1257 $K^- P \rightarrow K^* N$ AND KN^* AT 3 Gev/c AND A COMPARISON BETWEEN K^+ AND K^- REACTIONS. R. Barloutaud (CEN, Saclay, France), A. Leveque, C. Louedec, et al. Phys. Letters, 12: 352-5(Oct. 15, 1964).

The cross section, angular distribution, and K^* density matrix are measured for $K^- + p \rightarrow K^{*-} + p$ followed by $K^{*-} \rightarrow \bar{K}^0 + \pi^-$ at a K^- momentum of 3 Bev/c, and are found to agree qualitatively with similar measurements made on $K^+ + p$ reactions. The cross section for $K^- + p \rightarrow \bar{K}^0 + N^{*0}$-(1238) followed by $N^{*0}(1238) \rightarrow p + \pi^-$ is found to be an order of magnitude lower than that for the $K^+ + p$ reaction. Reasons for these similarities and dissimilarities are proposed. The analysis indicates that at 3 Bev/c, processes more complex than those considered have only a slight effect on the interaction parameters. (T.F.H.)

1258 RESONANCE PRODUCTION BY 8 Gev/c POSITIVE PIONS ON PROTONS. AACHEN–BERLIN–CERN COLLABORATION. M. Deutschmann (Technische Hochschule, Aachen), R. Schulte, H. Weber, et al. Phys. Letters, 12: 356-60(Oct. 15, 1964).

About 7000 two- and four-prong events, produced by 8-Bev/c positive pions on protons in a bubble chamber, are measured and analyzed using computer systems. Cross sections for the various channels are calculated. About 60% of the 2-prong and 50% of the 4-prong events correspond to reaction channels in which no more than one neutral particle is produced. Resonance effects are studied. (T.F.H.)

1259 NEUTRON-NEUTRON SCATTERING AT LOW ENERGIES. Michael J. Moravcsik (Univ. of California, Livermore). Phys. Rev., 136: B624-30(Nov. 9, 1964). (UCRL-7854-T)

This paper investigates the information contained in a neutron-neutron scattering experiment at low energies, which could be performed by colliding beams coming from an underground nuclear explosion. The significance of such an experiment is discussed from the point of view of a check on charge symmetry and charge independence, and it is found that because of the electromagnetic complications in proton-proton scattering, and because of the proton-neutron mass difference, the knowledge of neutron-neutron scattering would be of considerable value. The functional form of the experimental data that is most convenient for analysis, and the approximate relative magnitude of the terms is investigated, and it is concluded that for the kind of experiment envisaged (measuring cross sections to 10% from 20 kev to 2 Mev) only two parameters should be kept in the effective-range expansion. The connection between the number and distribution of energies at which the cross section is measured and the error on the individual measurements, on the one hand, and the accuracy of the effective-range parameters deduced from the experiments, on the other, is given explicitly and is found also to depend on the absolute magnitude of the scattering length. The results show that ten 10% measurements, suitably distributed between 20 kev and 2 Mev, can determine the sign of the scattering length to four standard deviations, the magnitude of the effective range to 50 to 70%, and the magnitude

of the scattering length to about 3%. Finally, the relationship between the variation of the effective-range parameters and the corresponding variation in the parameters of the scattering potential is studied, and it is found that, while this relationship is strongly shape-dependent, a small change in the potential parameters, in any case, results in a large change in the scattering length, but a small one in the effective range. Numerical relationships show that, even in the worst case, the variation in the scattering length is about eight times the variation in the potential parameter. It is concluded that a 10% experiment at 20 energies between 20 kev and 2 Mev would be able to get information on the potential parameters sufficiently accurately so that charge-dependent or charge-symmetry violating effects could be detected. (auth)

1260 MODEL THREE-BODY PROBLEM. R. Aaron (Northeastern Univ., Boston), R. D. Amado, and Y. Y. Yam. Phys. Rev., 136: B650-9(Nov. 9, 1964).

Solutions are obtained for a three-dimensional model three-body problem involving a spinless D particle and a spinless n particle with coupling $D \rightleftharpoons n + n$. D-n scattering and D-n bound states are studied. The model is soluble in the sense that one obtains a linear, one-dimensional Fredholm equation for each partial wave in n-D scattering. The equations are solved numerically on a high-speed computer for different values of the interaction strength and for different values of a size parameter used in the interaction form factor. In particular, the interaction-strength limit, which corresponds to making the D a bound state of the n's, is studied. In this limit there are two three-body bound s states. The n-D scattering phase shifts obey a Levinson's theorem and also show the expected kink at the threshold for $n + D \rightarrow 3n$. The angular distribution for n-D scattering has considerable variation and shows the backward peak characteristic of an exchange mechanism. When parameters are chosen in the model to make the D fit the deuteron, the major features of nucleon-deuteron scattering are reproduced except at very low energies when the three-particle bound states dominate and our neglect of spin is important. (auth)

1261 CAN A SCALAR MESON "BOOTSTRAP" ITSELF? P. D. B. Collins (Univ. of California, Berkeley). Phys. Rev., 136: B710-13(Nov. 9, 1964). (UCRL-11463)

It is shown that although a scalar meson can be described by a renormalizable field theory, it is not possible for such a particle to "bootstrap" itself, because the force arising from the crossed channels is too great. This result is in accordance with the "bootstrap" philosophy that there should be only one solution of the S-matrix equations consistent with maximal analyticity of the second kind, and also indicates the need for symmetries in strong interactions. (auth)

1262 MASS SUM RULES FOR VECTOR MESONS AND PROPERTIES OF ω AND φ MESONS. Ken Kawarabayashi (Northwestern Univ., Evanston, Ill. and Inst. for Advanced Study, Princeton, N. J.). Phys. Rev., 136: B714-19(Nov. 9, 1964).

A mass sum rule for nonet vector mesons and decay and production properties of ω and φ are investigated, assuming a particular broken SU(3) symmetry in strong interactions. A simple model in which boson states are assumed to be composed of two SU(3) triplets is considered in detail, and the following mass sum rule for the nonet is derived: $2M_{K^*} - M_\varphi \approx M_\rho - (M_\omega - M_\rho)/2$. A mixing angle between the T = 0 octet partner and the singlet can be fixed by the observed $\omega - \rho$ mass difference, which gives $\cos\theta \approx 0.64$. It is suggested that the decay rate of $\varphi \rightarrow \rho + \pi$ and the $g_{\varphi NN}$ coupling constant is proportional to the $\omega - \rho$ mass difference, in which case the two coupling constants g_B and g_Y, corresponding to baryon and hypercharge currents, respectively, can be fixed as follows: $g_B^2/4\pi \approx 3$, $g_Y^2/4\pi \approx 1.5$. This model also suggests a small F versus D ratio for 0^- octet-mesons and $P_{\frac{1}{2}}$ octet-baryon couplings. (auth)

1263 SPIN OPERATORS IN THE KEMMER THEORY. A. Sankaranarayanan (Ames Lab., Ames, Iowa). Phys. Rev., 136: B719-22(Nov. 9, 1964). (IS-892)

A discussion of the various conserved spin operators in the theory of spin-one particles is given. The algebraic properties and the interrelations of the various operators are also considered. The covariant forms of energy and spin projection operators are deduced and discussed. (auth)

1264 CROSSING RELATIONS AND LEGENDRE EXPANSIONS IN PION-PION SCATTERING. Takeshi Kanki and Arnold Tubis (Purdue Univ., Lafayette, Ind.). Phys. Rev., 136: B723-32(Nov. 9, 1964).

The direct use of crossing relations for pion-pion scattering amplitudes, outside the triangle bordered by the lines s = 0, t = 0, and u = 0 in the Mandelstam diagram, is not generally possible. This is because the regions of convergence of the usual Legendre expansions for the amplitudes are restricted by cross-channel cuts in appropriate $\cos\theta$ variables. These convergence difficulties may be relieved by suitably decomposing each amplitude into two terms. One term differs in analytic properties from the actual amplitude in that portions of the cross-channel cuts in $\cos\theta$ nearest $\cos\theta = \pm 1$ are absent. The Legendre expansion of this term has a larger region of convergence than that for the actual amplitude. The other term in the decomposition is expressed in terms of the Legendre series for physical scattering in the cross channels. The amplitudes so represented may now be continued from one physical region to another, and crossing relations may, in general, be directly applied outside the triangle. As a simple application of the formalism, the existence and approximate mass and width of the ρ meson are found to be simple consequences of analyticity, unitarity, and crossing symmetry. (auth)

1265 EXTRAPOLATION OF PROTON ELECTROMAGNETIC FORM FACTOR. [PART] II. J. S. Levinger and C. P. Wang (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 136: B733-41(Nov. 9, 1964).

The proton form factors were extrapolated to time-like momentum transfers to determine the spectral functions. The extrapolations were compared with preliminary measurements of the cross section for proton–antiproton annihilation into an electron–positron pair, for a time-like momentum transfer of 172 f^{-2}. This comparison determines an otherwise arbitrary parameter used in a conformal-transformation procedure of extrapolation. The constraint was also applied that electric and magnetic form factors are equal at time-like momentum transfer of $4M^2$. Spectral functions were found with a peak around 625 Mev, a zero around 1050 Mev, and a minimum around 1500 Mev. (auth)

1266 POSSIBLE EXPERIMENTAL CONSEQUENCES OF TRIANGLE SINGULARITIES IN STRANGE-PARTICLE PRODUCTION PROCESSES. Y. F. Chang and S. F. Tuan (Purdue Univ., Lafayette, Ind.). Phys. Rev., 136: B741-8 (Nov. 9, 1964).

Observable consequences of anomalous threshold singularity for triangle diagrams are examined with special reference to cases where baryon resonances of narrow width participate as an internal line in the E channel. It is found that the reaction $K^- + p \rightarrow K + \pi + \Xi$, with Ξ^* (1530) included as an internal line of the graph, offers the best experimental situation for detecting an anomalous singularity effect by studying the ($K\pi$) mass spectrum in final state. (auth)

1267 DYNAMICAL CALCULATIONS AND REGGE TRAJECTORIES IN THE PRESENCE OF SPIN. Ernest Abers and Fredrik Zachariasen (California Inst. of Tech., Pasadena). Phys. Rev., 136: B749-62(Nov. 9, 1964).

Some features of the Regge trajectory structure of scattering amplitudes for spinning particles, associated with the existence of a nonsense channel, are described. The restrictions imposed by smoothness in angular momentum on the input forces to dynamical calculations are then discussed. Some popular versions of the N/D method are not, in general, consistent with these restrictions, but can be made so by special choice of subtractions. We illustrate these ideas in detail for the scalar-vector scattering

amplitude. The characteristic new feature is a trajectory α_0 which goes to zero in the limit of small coupling constant; it emerges naturally from the N/D method with our special subtractions. The dynamics of particles lying on this trajectory are curious, and may reflect a weakness of the N/D approximation rather than physics, since strong forces (large coupling constants) are not needed to bring it up to a physical value of the angular momentum. As an example, we perform a simple bootstrap calculation for pseudoscalar mesons, assuming that they lie on such a trajectory. (auth)

1268 GAUGE THEORY OF ELEMENTARY INTERACTIONS. Abdus Salam and J. C. Ward (Imperial Coll. of Science and Tech., London). Phys. Rev., 136: B763-8 (Nov. 9, 1964).

F and D couplings of baryons and mesons are shown to arise naturally with a simple extension of the gauge formalism to a $(SU_3 \times SU_3)_L \times (SU_3 \times SU_3)_R$ group structure. In its general formulation the theory needs parity doublets of (0+) and (0−) ninefolds. It admits of (two types of F and D coupled) (1+) and (1−) vector and axial-vector meson multiplets, a specially attractive combination of currents which emerges from the formalism being an equal mixture of vector F with axial-vector D [the case of $(SU_3)_L/(SU_3)_R$]. The theory also admits an approximate type of quantum number. (auth)

1269 WEAK INTERACTIONS AND SELF-CONSISTENT THEORIES. Mahiko Suzuki (Tokyo Univ.). Phys. Rev., 136: B769-73(Nov. 9, 1964).

It is pointed out that the so-called self-consistent theories encounter obvious contradictions with experimental facts if the weak interactions are introduced into them in a simple manner. By the self-consistent theories we mean the self-consistent quantum electrodynamics with vanishing bare masses, the spontaneous breakdown of strong-interaction symmetries, and the like. It follows at the same time that attempts to realize the μ-e splitting self-consistently are wrong even if the bare mass is finite. Possible modifications are also discussed, which make the weak interactions compatible with the self-consistent theories. (auth)

1270 SELF-CONSISTENT CALCULATION OF THE SCATTERING AMPLITUDE AND THE DIFFRACTION PEAK. Keiji Igi (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev., 136: B773-8(Nov. 9, 1964).

The $\pi\pi$ scattering is studied at low momentum transfers, in order to understand diffraction scattering. A self-consistent calculation of the position $\alpha(s)$ and reduced residue $\gamma(s)$ of the Pomeranchuk-Regge trajectory is carried out. The result of the calculation under certain simplifying approximations is that the s dependence of $\gamma(s)$ is responsible for the sharp forward peaking in the high-energy scattering and can roughly reproduce the experimental width of the diffraction peak derived from the factorization theorem. (auth)

1271 MEASUREMENT OF $p + p \rightarrow \pi^+ + d$ AT HIGH MOMENTUM TRANSFERS. W. F. Baker (Brookhaven National Lab., Upton, N. Y.), E. W. Jenkins, A. L. Read, A. D. Krisch, J. Orear, R. Rubinstein, D. B. Scarl, and B. T. Ulrich. Phys. Rev., 136: B779-82(Nov. 9, 1964).

Three measurements of the differential cross section for $p + p \rightarrow \pi^+ + d$ have been made at incident laboratory momenta 11.6, 15.0, and 22.9 Bev/c and corresponding deuteron angles 55.7, 43.4, and 34.7° in the center-of-mass system. The internal proton beam was made to strike a polyethylene target, and coincidences were taken between the outgoing pion and deuteron by placing counter telescopes both inside and outside the AGS ring. Both particles were momentum analyzed and the deuteron was identified by the use of a gas-filled differential Čerenkov counter. The pion was identified by time of flight. The total number of protons incident on the target was obtained by radiochemical analysis of the ^{7}Be spallation product from carbon. Differential cross sections in the region 10^{-33} to 10^{-34} cm^2/sr in the cm system were obtained. Cross sections are ~10^4 times smaller than other measurements at lower energies and smaller angles; we conclude that this process decreases rapidly both with increasing energy and with increasing cm angle. (auth)

1272 SUM RULES FOR COUPLING CONSTANTS IN BROKEN SU(3) SYMMETRY. Virendra Gupta and Virendra Singh (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev., 136: B782-6(Nov. 9, 1964).

The coupling constant sum rules for the decay of an octet, icosuplet, and 27-plet to the two octets are derived in the broken SU(3) symmetry scheme. (auth)

1273 EMPIRICAL PARTIAL-WAVE ANALYSIS OF π + p ELASTIC SCATTERING ABOVE 1 Gev/c. Martin L. Perl and Mary C. Corey (Stanford Univ., Calif.). Phys. Rev., 136: B787-803(Nov. 9, 1964). (SLAC-PUB-28)

A partial-wave equation has been used to fit most of the recent π + p differential cross-section measurements above 1 Bev/c. The phenomenological parameters a_l were determined by the method of weighted least squares, with the further requirement that they be real and they satisfy either constraints of the form $1 \geq 1 - a_l \geq 0$ (which allows the scattering to be interpreted as purely absorptive) or the more relaxed constraints $2 \geq 1 - a_l \geq 0$. This equation, with the requirements, does not allow the scattering amplitude to have a spin-flip part or a real part, but for one set of data further terms were added to allow these additional parts of the scattering amplitude. For each differential cross section at the various energies, a set of a_l values was determined, which in almost all cases fit the measured cross sections. These sets of a_l parameters have two properties in common. First, all a_l except a_0 satisfy $1 \geq 1 - a_l \geq 0$. The a_0 parameters (s-wave amplitudes) required $1 - a_0 \geq 1$ except for the higher energies where $1 \geq 1 - a_0 \geq 0$ was obtained. Second, graphs of $1 - a_l$ versus l (one graph for each different cross section measurement) show that $1 - a_l$ decreases rather smoothly with increasing l and that the curve is either roughly linear or concave upward. No striking variations in the a_l parameters are observed when the energy is close to one of the π + p total cross section resonances. The a_l parameters are interpreted using $1 - a_l$ as a measure of the absorption of the lth partial wave by inelastic processes. Differential cross section measurements of π^- + p at 2.01 Bev/c and of π^+ + p at 2.02 Bev/c are given. (auth)

1274 s-WAVE K−N SCATTERING BY THE N/D METHOD. D. P. Roy (Tata Inst. of Fundamental Research, Bombay). Phys. Rev., 136: B804-7(Nov. 9, 1964).

The K−N s-wave scattering lengths and effective-range parameters have been calculated for both isotopic spin states, using the N/D method. The nearby part of the interaction cut has been approximated by two poles, whereas the entire distant cut has been replaced by two effective-range poles at predetermined positions, but with unknown residues. The residues of the effective-range poles are determined by matching the N/D amplitude with that calculated with a fixed energy dispersion relation, at two properly chosen points. In calculating the latter amplitudes only the contributions of Λ, Σ, Y_1^*, ρ, and ω exchange terms are retained and the values of Y_1^*, ρ, and ω coupling constants are taken from a unitary symmetry scheme. The calculated values of scattering length, effective range, and low-energy phase shifts for the I = 1 state agree with experimental results. (auth)

1275 RELATION AMONG THE $\Xi\ ^1/_2{}^*$, $Y_1{}^*$, $N_{^3/_2}{}^*$ DECAY WIDTHS IN BROKEN UNITARY SYMMETRY. C. Becchi, E. Eberle, and G. Morpurgo (Universitâ, Genoa and Istituto Nazionale di Fisica Nucleare, Geneva). Phys. Rev., 136: B808-10(Nov. 9, 1964).

The decay amplitudes of the decuplet particles $\Xi^*_{^3/_2}$ (1530), Y_1^* (1385), and $N^*_{^3/_2}$ (1238) into a baryon and a pion have been calculated, assuming that the interaction giving rise to such decays consists of a unitary symmetric part plus all the terms violating unitary symmetry (which transform as the T^1_3 component of a unitary tensor). It is shown that, contrary to first expectation, only three undetermined coupling constants appear in the calculation of the four amplitudes G_1, G_2, G_3, G_4 for the decays $\Xi^*_{^3/_2} \rightarrow \Xi + \pi$; $Y_1^* \rightarrow$

$\Sigma + \pi$; $Y_1^* \rightarrow \Lambda + \pi$; and $N_{\frac{1}{2}}^* \rightarrow N + \pi$ respectively. One can therefore predict a relation among the above four amplitudes, which turns out to be $G_4 = -(3/\sqrt{2})G_3 - (\sqrt{3}/2)G_2 + (\sqrt{6})G_1$. With the values of the widths this relation is satisfied. (auth)

1276 METHOD OF REDUCING THE UNCERTAINTY IN NEUTRINO MASS. Robert R. Lewis, Jr. (Univ. of Michigan, Ann Arbor). Phys. Rev., 136: B811-15(Nov. 9, 1964).

Both the neutrino mass and the Fermi level of a degenerate neutrino gas are limited by experiments on the decay spectra near the maximum recoil momentum (or maximum electron energy). The possibility of studying this portion of the spectrum by resonance fluorescence of a subsequent gamma ray, is examined. Discussion of the resolution available with this technique indicates that an improvement in the limits on neutrino mass and Fermi level may be possible. (auth)

1277 EQUIVALENCE BETWEEN FOUR-FERMION AND YUKAWA COUPLING, AND THE $Z_3 = 0$ CONDITION FOR COMPOSITE BOSONS. D. Lurie and A. J. Macfarlane (Univ. of Rochester, N. Y.). Phys. Rev., 136: B816-29 (Nov. 9, 1964). (UR-875-41)

The conditions are derived for equivalence: between a four-Fermi theory with pseudoscalar coupling and a Yukawa theory with pseudoscalar bosons; and the same in the corresponding vector case. In general, two conditions are found to be both necessary and sufficient. The first is a condition for the existence of an appropriate boson bound state in the four-Fermi theory. The second condition is that the boson wave function renormalization constant Z_3 in the Yukawa theory be equal to zero. Results by consideration of fermion-fermion scattering in the chain approximation are first derived, and then proved valid to all orders in perturbation theory. The degenerate vacuum theories in the chain approximation are discussed. In each of these four-Fermi theories, the existence of boson bound states (massless pseudoscalar and massive scalar bosons in the former case, massless vector bosons in the latter) follows automatically from self-consistency conditions. Hence to have equivalence to Yukawa theories in which the bosons are described by elementary fields, we need only impose the $Z_3 = 0$ conditions on the Yukawa theories. Finally, the theory of quantum electrodynamics without electromagnetic field is discussed. It is to be stressed that we deal throughout with full-scale relativistic field theories of physical consequence. (auth)

1278 HIGHER SYMMETRIES FOR THE VECTOR MESONS. I. S. Gerstein and M. L. Whippman (Univ. of Pennsylvania, Philadelphia). Phys. Rev., 136: B829-35 (Nov. 9, 1964).

To explain the existence of nine vector mesons and the degeneracy of the unmixed masses of the ϕ and ω, we postulate that the vector mesons possess a higher symmetry than SU_3. Various properties of the adjoint representation of SU_n are discussed and three simple models for the symmetry-breaking interaction are proposed. The results to SU_4 are specialized and good agreement between mass formulas and experiment are found. A new quantum number, "hyperstrangeness," and six hyperstrange vector mesons with fractional hypercharge but integral electric charge are introduced. These particles, which form an isotopic doublet and an isotopic singlet (together with their antiparticles) are approximately degenerate with the ρ and K^*, respectively, and are stable with respect to the strong and electromagnetic interactions. The production and decay of these particles are discussed. (auth)

1279 SHRINKAGE OF THE EFFECTIVE CORE IN THE SCATTERING OF PARTICLES OF ARBITRARY SPIN. Giuliano Patergnani and Kunio Yamamoto (Univ. of Chicago). Phys. Rev., 136: B836-9(Nov. 9, 1964).

A theorem proving the shrinkage of the effective core is extended to the scattering of particles of arbitrary spin with the result that any matrix element of the scattering amplitude has at high energy no significant contribution from the "partial waves" whose total angular momenta are larger than const $\ln^2 s/\sin\theta$. It is also shown that any matrix element of the scattering amplitude is bounded by min(const $\ln^3 s/\sin^2\theta$, const $s \ln^2 s$) at high energy. (auth)

1280 ANGULAR CORRELATIONS IN THE THREE-PION SYSTEM AND THE DIFFRACTIVE DISSOCIATION OF A PION. P. Dennery (Université de Paris, Orsay, France) and A. Krzywicki. Phys. Rev., 136: B839-42 (Nov. 9, 1964).

The process of diffractive dissociation of a pion, $\pi + N \rightarrow 3\pi + N'$ is studied, without assuming that the target interacts coherently. A general form of some angular correlations of the three pions is found, when they are in a state of total angular momentum less than 3. It is shown that these angular correlations either depend solely on the dynamics of the crossed channel or, if they depend also on the dynamics of the 3π system, they do so in a straightforward way. (auth)

1281 PION PRODUCTION WITHOUT ANNIHILATION IN ANTIPROTON-PROTON INTERACTIONS AT 3.6 Gev/c. H. C. Dehne, E. Lohrmann, E. Raubold, P. Soeding, M. W. Teucher, and G. Wolf (Physikalisches Staatsinstitut, Hamburg and Deutsche Elektronen-Synchrotron DESY, Hamburg). Phys. Rev., 136: B843-51(Nov. 9, 1964).

Interactions of antiprotons were studied at a momentum of 3.6 Bev/c in a hydrogen bubble chamber. Particular attention was paid to single and multiple pion production without annihilation. Cross sections for the various pion-production channels are given. The total cross section for pion production without annihilation (not including strange-particle production) is $18.6^{+2.4}_{-2.2}$ mb. Single pion production is found to agree with the predictions of the one-pion-exchange model for small values of the four-momentum transfer. Double pion production in the reaction $\bar{p}p \rightarrow p\bar{p}\pi^+\pi^-$ agrees with the one-pion-exchange model for all values of the four-momentum transfer, if all possible diagrams are taken into account. The main contribution comes from events where a $3/2-3/2$ pion-nucleon isobar-anti-isobar pair is produced. For these events the angular distribution and the decay angular distributions of the isobars are also in agreement with the one-pion-exchange model. (auth)

1282 ASYMPTOTIC SELF-CONSISTENCY OF PROPAGATORS AND FORM FACTORS. R. Delbourgo (Univ. of Wisconsin, Madison). Phys. Rev., 136: B851-8(Nov. 9, 1964).

From a consideration of the elastic unitarity equations for the propagators Δ and vertex function Γ, it is argued that the following high-energy behaviors are self-consistent: $\Gamma^{-1}(s) \approx s^{\frac{1}{4}(a+b+c-1)}\ln s$, $\Delta_A(s) \approx s^{a-1}\ln s$, ... for the interactions among three particles A, B, and C (spins a, b, and c, respectively). (auth)

1283 COULOMB SCATTERING OF DIRAC PARTICLES. R. L. Gluckstern and S. R. Lin (Yale Univ., New Haven). Phys. Rev., 136: B859-63(Nov. 9, 1964).

The expressions for the coulomb scattering amplitudes F and G up to α^4 terms ($\alpha = Z/137$) for arbitrary $q = \alpha/\beta$ are given. These expressions are used to evaluate the cross section $d\sigma/d\Omega$ and the asymmetry function S at small angles. The behavior of F and G as well as $d\sigma/d\Omega$ and S near $\theta = 180°$ is also discussed. The approximation is then extended to a screened potential by introducing a cutoff parameter $e^{-\mu r}(\mu \ll 1)$ in the partial-wave series. The scattering amplitudes and $d\sigma/d\Omega$ and S are compared with the corresponding coulomb case. (auth)

1284 SCATTERING OF A HIGH-INTENSITY, LOW-FREQUENCY ELECTROMAGNETIC WAVE BY AN UNBOUND ELECTRON. Zoltan Fried (Naval Ordnance Lab., Silver Spring, Md. and Univ. of California, Santa Barbara) and Joseph H. Eberly. Phys. Rev., 136: B871-87(Nov. 9, 1964).

"Thomson" scattering of a high-intensity, low-frequency, circularly-polarized electromagnetic wave by a free electron is considered. It is found that by neglecting radiative corrections and pair effects, the Feynman-Dyson perturbation expansion is summable, and the sum can be analytically

continued in the form of a sum of continued fractions. The boundary conditions are imposed that at $t = \pm\infty$ the photons and target electron propagate as free particles. In the kinematics, no intensity-dependent frequency shift is found in the scattered photon. In the dynamics, an expression is obtained for the scattering amplitude. Both of these originate in the choice of boundary conditions. Instead of treating the asymptotic radiation field classically, states as linear combinations of occupation-number states are chosen. Finally, a mixed set of classical and quantum boundary values is used. (auth)

1285 POSSIBLE CHAIN OF RESONANCES. Richard H. Capps (Northwestern Univ., Evanston, Ill.). Phys. Rev. Letters, 13: 536-8(Oct. 26, 1964).

Using the SU(3) model and static dispersion relations, it is found that the existence of a chain of resonances involving very many particles is possible. (T.F.H.)

1286 THE N/D METHOD AND THE PION-PION SCATTERING. Toshimi Adachi (Tokyo Metropolitan Technical Coll.), Ryuji Kawamura, and Tsuneyuki Kotani. Progr. Theoret. Phys. (Kyoto), 32: 126-37(July 1964).

In most recent calculations based on the N/D formalism, the N function is replaced by the appropriate Born terms. Thus the resulting amplitude, N/D, includes a normalization point s_0. This s_0 dependence is not small. If the coupled integral equations for N and D are solved, then N/D should have no s_0 dependence. If the left-hand singularities are approximated by a set of poles, the integral equation for N can be solved analytically. The amplitude N/D is expressed by an analytic function which does not involve s_0. The relations between a resonance position ($\underline{m}$) and its reduced width (γ^2) are determined without any arbitrariness, in principle. This method is applied to the p-wave π-π resonance. It is shown that self-consistency can not be achieved for any reasonable values of $\underline{m}$ and γ^2, if the Born term is attributed to the meson (ρ) exchange as the left hand cut. In order to make a bootstrap mechanism operative, effects that make scattering amplitudes less singular at larger negative energies must be taken into account. They may be substituted by introducing a phenomenological cutoff. (auth)

1287 POLE APPROXIMATION TO THE DECAYS OF THE Ω^- PARTICLE ($\simeq$1680 Mev). Mahiko Suzuki (Tokyo Univ.). Progr. Theoret. Phys. (Kyoto), 32: 138-43(July 1964).

The partial decay rates of the Ω^- particle ($\simeq$1680 Mev, $I = 0$, $Y = -2$) were calculated in the pole approximation for the weak interactions. The octuplet spurion was assumed as well as the SU_3-symmetric strong interactions. (auth)

1288 QUARTET SCHEME FOR ELEMENTARY PARTICLES. Ziro Maki and Yoshio Ohnuki (Nagoya Univ., Japan). Progr. Theoret. Phys. (Kyoto), 32: 144-58(July 1964).

A possible unified model for elementary particles is developed by generalizing the viewpoint of the Sakata-Nagoya model. Instead of the Sakata triplet (p,n, and Λ), the quartet of new baryons χ_ϕ and χ (χ_1, χ_2, and χ_3) of spin $\frac{1}{2}$ is used, of which χ_ϕ belongs to U(1), whereas the other three belong to U(3). Strong interactions are subjected to a "broken $U(1) \times U(3)$" symmetry. The baryon octet (N, Σ, Λ, and Ξ) and meson octets (K, π, η, $\overline{K}$; etc.) are interpreted, respectively, as the three ($\chi\overline{\chi}\chi_\phi$)- or two ($\chi\chi$)-body composite systems both belonging to 8-dimensional representations of SU(3). One of the crucial tests of the model is the prediction of triplet mesons ($\chi\overline{\chi}_\phi$), the isodoublet of which can be identified with mesons (κ). The baryon quartet, χ_ϕ and χ, corresponds to four leptons in the sense of "modified" baryon-lepton symmetry, permitting explanation of Cabibbo's phenomenological weak interaction as a consequence of the present scheme. (auth)

1289 OBSERVABLES OF PARTICLES OF SPINS 0 AND 1. P. M. Mathews and A. Sankaranarayanan (Univ. of Madras). Progr. Theoret. Phys. (Kyoto), 32: 159-65 (July 1964).

The "observable" position and other operators of particles of spins 0 and 1 (described by the Sakata-Taketani equations in Hamiltonian form) are investigated. It is shown that these are uniquely determined if it is required that the observable position must satisfy certain physically reasonable criteria, previously applied to Dirac particles. The position operator coincides with that obtained by Case, who, however, assumed its form in a particular representation. (auth)

1290 CONSEQUENCES OF OCTUPLET SCALAR MESONS IN THE ELECTROMAGNETIC MASS DIFFERENCES OF THE BARYONS. Mahiko Suzuki (Tokyo Univ.). Progr. Theoret. Phys. (Kyoto), 32: 166-7(July 1964).

It is shown that the electromagnetic mass differences of the baryons are explained by octuplet scalar mesons which couple with the octuplet baryons almost through F-coupling. (D.C.W.)

1291 ON THE SOLUTION OF THE N/D METHOD. Toshimi Adachi (Tokyo Metropolitan Technical Coll.) and Tsuneyuki Kotani. Progr. Theoret. Phys. (Kyoto), 32: 169-71(July 1964).

An expression for the partial-wave amplitude in the N/D method is derived. (D.C.W.)

1292 ON COMPLEX SPHERICAL HARMONICS. Mineo Ikeda (Hiroshima Univ.). Progr. Theoret. Phys. (Kyoto), 32: 178-80(July 1964).

The properties of the spherical functions of SU(3) or U(3) are summarized. (D.C.W.)

1293 VECTOR MESON EFFECTS IN KAON-NUCLEON SCATTERING. Tomoya Akiba and Fujio Takagi (Tohoku Univ., Sendai). Progr. Theoret. Phys. (Kyoto), 32: 242-53 (Aug. 1964).

The effects of vector mesons (ρ, ω, φ) on low-energy kaon-nucleon scattering are investigated under the assumption that the vector-meson-exchange interaction dominates the other interactions. The coupling forms of the vector mesons to nucleons are taken so as to be consistent with the nucleon electromagnetic-form-factor data. In addition, the universal nature of the ρ-couplings, as revealed by experiments, is considered. There is one undetermined coupling constant of the $I = 0$ vector mesons, which is arbitrarily adjusted by K-nucleon scattering data. The value obtained for this coupling constant is shown to be reasonable from the view points of the vector meson theory and the octet version of SU(3) symmetry. The model can explain the main features of K-nucleon scattering. However, some experiments, such as the isotropy of the K^+-p angular distribution, cannot be understood by the vector meson effects alone. Further consideration of the Yukawa interactions (KNY) seems not to be helpful. (auth)

1294 PHASE SHIFTS OF PION-PION SCATTERING. Hiroyuki Kanada and Keiji Watanabe (Nagoya Univ., Japan). Progr. Theoret. Phys. (Kyoto), 32: 254-62(Aug. 1964).

The phase shifts in pion-pion scattering are calculated by using the N/D method. The subtractions are done for N and D, so that there may be P-wave and S-wave resonances that correspond to the ρ meson and the ABC particle, respectively. The one-boson-exchange approximation is investigated. It is found that the approximation is valid if there is a resonance corresponding to the boson exchanged. The cutoff dependence of the integral equation is examined. The results are compared with the pion-pion scattering experiment. (auth)

1295 BOSON- AND BARYON-RESONANCES IN THE OCTET MODEL. Masataka Hosoda and Yoneji Miyamoto (Tokyo Univ. of Education). Progr. Theoret. Phys. (Kyoto), 32: 263-78(Aug. 1964).

The investigation of the levels of resonances is made by introducing the various dynamical mechanisms in the framework of the octet scheme. Discussions are given of: the possible existence of ps-octet (Π octet) in baryon-antibaryon (B-$\overline{B}$) system and the reason for the appearance of Π octet with D-type coupling to B; the possible existence of vector octet and vector singlet with lighter mass in B-$\overline{B}$,

$B\bar{B}$-2Π and 2Π systems; the possible classification of Y_1^* as unitary singlet; the bootstrap model of baryon in Π-B system; and the various models for the third and fourth baryonic excited states. (auth)

1296 ON THE BRANCHING RATIO OF THE DECAY OF THE Y_1^* (1382 Mev) IN THE BROKEN DECUPLET ($J^\pi = 3/2^+$). Mahiko Suzuki (Tokyo Univ.). Progr. Theoret. Phys. (Kyoto), 32: 279-82(Aug. 1964).

A sum rule is derived for the decay amplitudes of the decuplet baryon isobars ($J^\pi = 3/2^+$) to the lowest order of symmetry-violating interactions. The rule holds within the experimental errors. The anomalous branching ratio of the Y_1^* decay is well understood in terms of symmetry-violating effects. (auth)

1297 A UNITARY SYMMETRIC SPURION FORMALISM OF WEAK INTERACTION. Hideaki Nagai (Hokkaido Univ., Sapporo). Progr. Theoret. Phys. (Kyoto), 32: 283-300(Aug. 1964).

Roles played by unitary symmetry in weak interactions are investigated in the framework of a spurion formalism. By making use of spurions, currents of strongly interacting particles are constructed formally in octet form, and the interaction Hamiltonian is written in a form of current-current interaction, which is apparently invariant under the three-dimensional unitary group. Lepton current can be introduced in such a way that the transitions with $|\Delta S| = 2$ do not occur. The isotopic spin selection rule $|\Delta I| = 1/2$ holds for nonleptonic decays of baryons, but in leptonic processes, ($|\Delta I| = 3/2$) transitions also occur, which lead to $\Delta S/\Delta Q = -1$. If one assumes that the vector current is conserved in the unitary-symmetry limit, only terms corresponding to ($\Delta S/\Delta Q = 1$) transitions are included in the vector current, and thus transitions with $\Delta S/\Delta Q = -1$ occur mainly through the axial-vector interaction. Further, if we assume that the weak interaction Hamiltonian is invariant under R-reflection, we can fix the relative strength among most weak coupling constants by comparing our results with the experimental values of leptonic decays of baryons and the decay ratio of $K \to \mu\nu$ process to $\pi \to \mu\nu$. Using these coupling constants, we have derived the following conclusions consistent with experiments: the leptonic decay probabilities of hyperons ($|\Delta S| = 1$) are about one-tenth of the probability of ordinary beta decay; the $\Sigma^+ \to n\mu^+\nu$ decay probability ($\Delta S/\Delta Q = -1$) is about one-tenth of that of leptonic decays of hyperons; and relative decay probabilities and asymmetric coefficients of nonleptonic decays of baryons are all consistent with experiment. (auth)

1298 ON THE INTERMEDIATE BOSON HYPOTHESES OF WEAK INTERACTIONS. Kunio Itami (Tokyo Univ.), Seitaro Nakamura, Nobumichi Mugibayashi, and Yasutaka Tanikawa. Progr. Theoret. Phys. (Kyoto), 32: 301-5(Aug. 1964).

It is suggested that consequences inferred from the intermediate-boson hypotheses of weak interactions be compared with the results of neutrino experiments. (T.F.H.)

1299 COMPOSITE PARTICLES AND VANISHING WAVE FUNCTION RENORMALIZATION CONSTANTS IN S-MATRIX THEORY. Masayuki Uehara (Univ. of Osaka Prefecture, Sakai, Japan). Progr. Theoret. Phys. (Kyoto), 32: 306-19(Aug. 1964).

Two methods have been known of deriving a relation between the coupling constant and the mass ratio for a S-state composite particle. With the first method, the relation is obtained from the condition that the wave function renormalization constant Z_3 is vanishing. With the second method, another relation is obtained from solving the S-wave scattering amplitude of the constituent particles through the N/D method under the condition that a pole of the composite particle should be given by a zero of D. It is shown that two relations thus obtained are inequivalent in most cases. In nonrelativistic potential model, the equivalence holds only when the potential has a zero range, namely, only in the model of the contact interaction such as the Lee model. (auth)

1300 MASS FORMULA IN BROKEN SYMMETRY. Yasunori Fujii, Munetake Ichimura, and Koichi Yazaki (Tokyo Univ.). Progr. Theoret. Phys. (Kyoto), 32: 320-36(Aug. 1964).

Validity of a linear mass formula in a broken symmetry scheme is investigated using a Lee-type model. It is concluded that such a mass formula can be valid under certain conditions, while there are some cases where no mass formula is expected. It is also discussed that a perturbative mass formula may apply better to the poles of K-matrices (called K-masses) than to the actual masses. The consistency of an assumed linear K-mass formula is examined in the case of the decuplet $P_{\frac{3}{2}}$ resonances in SU_3. (auth)

1301 TRIO-SPINOR FORMALISM AND BARYON-LEPTON SYMMETRY. Yoshio Yamaguchi (Tokyo Univ.). Progr. Theoret. Phys. (Kyoto), 32: 337-42(Aug. 1964).

The formulation of "trio-invariant" theories is briefly presented on the basis of two-valued (or "spinor") representation of the symmetry group S_3 of order 3. One can predict the existence of an entirely new type of particles, which exhibit the trio-spinor character. A new form of the baryon-lepton symmetry is proposed and its use for weak interactions is remarked. (auth)

1302 ELECTRIC CHARGES OF STRONGLY INTERACTING PARTICLES. IS THE K^0-MESON ELECTRICALLY NEUTRAL? Yoshio Yamaguchi (Tokyo Univ.). Progr. Theoret. Phys. (Kyoto), 32: 343-7(Aug. 1964).

The question is raised whether the "neutral" K^0 is electrically neutral. If not, the apparent mass difference of K_1 and K_2 will depend on experimental conditions. Other possible tests are briefly discussed. It is conceivable that an experiment and its interpretation (K^0 has very small charge $\sim 10^{-6}$) made by Leipuner et al. (Phys. Rev., 132: 2285 (1963)) are quite right. (auth)

1303 INTERNAL STRUCTURE AND SYMMETRY OF ELEMENTARY PARTICLES. [PART] II. Yasuhisa Katayama and Hideki Yukawa (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto), 32: 366-8(Aug. 1964).

A method is described for connecting the internal degrees of freedom in bilocal fields with the symmetry properties of elementary particles. Isospin operators are defined in the system in a Lorentz-invariant fashion, using only spherically symmetric internal eigenfunctions. It is concluded that Gaussian form factors should result, with respect to both space and time directions. (T.F.H.)

1304 SYMMETRY AND INTERNAL SPACE-TIME OF ELEMENTARY PARTICLES. Yasuhisa Katayama (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto), 32: 368-9(Aug. 1964).

It is shown that an equivalent description of the internal space-time of elementary particles using the Minkowski metric and the Euclidean metric yields some of the same operator combinations that are characteristic of broken-SU_3 symmetry models. (T.F.H.)

1305 THE THEORY OF WEAK INTERACTIONS. J. C. Taylor (Cambridge Univ., Eng.). Rept. Progr. Phys., 27: 407-67(1964).

The weak interactions of leptons are defined by a few principles: lepton conservation, two-component neutrinos, and the use of the $1 + \gamma_5$ components of electrons and muons. Baryons, pions and kaons interact with leptons through a current, the parity, isotopic spin, and strangeness structure of which is to be determined by experiments on nuclear beta decay, muon capture, and leptonic decay of hyperons and mesons. The weak interactions of baryons, pions, and kaons among themselves are controlled by a Hamiltonian, the quantum numbers of which are likewise to be determined from the pionic decays of kaons and hyperons. This Hamiltonian seems to have a simple structure, defined by the $\Delta T = 1/2$ rule. 170 references. (auth)

1306 THE OMEGA-MINUS EXPERIMENT. William B. Fowler and Nicholas P. Samios. Sci. Am., 211: No. 4, 36-45(Oct. 1964). (BNL-8200)

An account of how the hyperon (Ω^-) was produced and identified is presented. (C.E.S.)

1307 ELEMENTARY PARTICLES—SIMPLE OR COMPLEX? S. Devons (Columbia Univ., New York). Sci. Progr. (London), 52: 543-56(Oct. 1964).

Symmetry schemes of strongly interacting elementary particles proposed in the past few years include a prediction that an additional particle, the Ω^-, should exist. The recent experimental discovery of this particle, with properties almost precisely as predicted, has led to a surge of confidence that some basic underlying principles regarding the properties of elementary particles may soon be uncovered; and there is now a veritable plethora of symmetry schemes and rules, some purely empirical, others more ambitiously based on physical ideas, seeking to explain and predict properties of the particles. The development of the knowledge of elementary particle properties and their interpretation in terms of symmetry schemes is outlined. (auth)

1308 THE HYPOTHESIS OF CONSERVED VECTOR CURRENT AND BETA DECAY OF THE CHARGED PION. P. Depommier (Université, Grenoble, France). p.137-40 of "Physique Nucleaire des Basses Energies." Louvain, Belg., Librairie L. Wouters, 1962. (In French)

The theory of conserved vector current (CVC) proposed by Feynman and Gell-Mann to explain that the constant g_v deduced from muon decay is very close to that obtained from ^{14}O decay is briefly summarized. The experimental value of the ratio $(\pi^+ \to \pi^0 + e^+ + \vartheta)/(\pi^+ \to \mu^+ + \vartheta)$ is $1.7 \pm 0.5 \times 10^{-8}$, compatable with the value $1.06 \pm 0.02 \times 10^{-8}$ deduced from the CVC theory. (J.S.R.)

1309 THE ELECTRON-NEUTRON INTERACTION. Leslie L. Foldy (Case Inst. of Tech., Cleveland). p.290-339 of "Lectures from the Second Neutron Physics Conference, Boyne Mountain, Michigan, June 1962." Ann Arbor, Mich., Michigan Memorial-Phoenix Project, 1964.

Scattering of slow neutrons by atoms, experiments on the electron-neutron interaction, the character of the interaction, relativistic and nonrelativistic phenomenology of electron-nucleon scattering, kinematics of a Dirac particle, high-energy electron-nucleon scattering, and the theory of nucleon structure are discussed. (C.E.S.)

1310 MESONS AND BARYONS. Suraj N. Gupta (Wayne State Univ., Detroit). p.340-71 of "Lectures from the Second Neutron Physics Conference, Boyne Mountain, Michigan, June 1962." Ann Arbor, Mich., Michigan Memorial-Phoenix Project, 1964.

A theory of mesons and baryons is formulated. Three-dimensional spinors, isocovariance and isocharge, inversion and hypercharge, charge conservation, multiplets of elementary particles, interactions of mesons and baryons, and experimental evidence for mesons and baryons are discussed. (C.E.S.)

1311 PROCEEDINGS OF THE SIENNA INTERNATIONAL CONFERENCE ON ELEMENTARY PARTICLES, 30 SEPTEMBER–5 OCTOBER, 1963. VOLUME I. Gilberto Bernardini and G. P. Puppi, eds. Bologna, Societa Italiana di Fisica, 1963. 708p. (CONF-216)

Separate abstracts have been prepared for 109 of 152 papers presented. Abstracts of 43 papers previously appeared in NSA (17: 23664, 31529, 32905, 37934, 37938, 39844, 41786 and 18: 930, 2623, 2655, 2660, 4453, 6029, 6047, 7463, 7464, 7465, 9160, 9235, 10924, 10935, 11206, 11215, 16789, 17063, 18697, 18725, 18729, 21017, 21019, 22402, 22741, 22758, 24428, 26262, 26282, 28348, 28437, 30506, 30575, 32573, 32575, and 40293). (A.G.W.)

For abstracts of individual papers see: 1133, 1134, 1312, 1313, 1314, 1315, 1316, 1317, 1318, 1319, 1320, 1321, 1322, 1323, 1324, 1325, 1326, 1327, 1328, 1329, 1330, 1331, 1332, 1333, 1334, 1335, 1336, 1337, 1338, 1339, 1340, 1341, 1342, 1343, 1344, 1345, 1346, 1347, 1348, 1349, 1350, 1351, 1352, 1353, 1354, 1355, 1356, 1357, 1358, 1359, 1360, 1361, 1362, 1363, 1364, 1365, 1366, 1367, 1368, 1369, 1370, 1371, 1372, 1373, 1374, 1375, 1376, 1377, 1378, 1379, 1380, 1381, 1382, 1383, 1384, 1385, 1386, 1387, 1388, 1389, 1390, 1391, 1392, 1393, 1394, 1395, 1396, 1397, 1398, 1399, 1400, 1401, 1402, 1403, 1404, 1465, 1466, 1661, 1662, 1663, 1664, 1665, 1666, 1667, 1668, 1669, 1670, 1671, and 1672.

1312 Ξ^0 PROPERTIES. L. Jauneau (Ecole Polytechnique, Paris), D. Morellet, U. Nguyen-Khac, et al. p.1-4 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

The properties of Ξ^0's produced by reactions of the type $K^- + N \to \Xi^0 + K^{0+} + n\pi$ were studied in the Ecole Polytechnique and CERN heavy liquid bubble chambers. Sixteen events in which two γ's from π^0 decay were seen were used to calculate the Ξ^0 mass from the Q-value of the Λ^0 and π^0. The value found was 1314.6 ± 1.5 Mev. Nine additional events with only one γ were used to calculate the mean life from the maximum likelihood formula. The value found was $1.86^{+0.15}_{-0.14} \times 10^{-10}$ sec. The α parameter was found to be $\alpha_{\Xi^0}\alpha_{\Lambda^0} = -0.3 \pm 0.4$. All results are in reasonable agreement with theoretical predictions. (A.G.W.)

1313 Ξ^- PROPERTIES. L. Jauneau (Ecole Polytechnique, Paris), D. Morellet, U. Nguyen-Khac, et al. p.4-8 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

The properties of Ξ^-'s produced mainly by reactions $K^- + (p,n) \to \Xi^- + (K^+, K^0)$ in the Ecole Polytechnique heavy liquid bubble chamber were studied. Results are as follows: the mass is 1321.4 ± 0.4 Mev; the lifetime is $1.86^{+0.15}_{-0.14} \times 10^{-10}$ sec; the asymmetry parameters are $\alpha = -0.44 \pm 0.11$, $\beta = -0.24^{+0.57}_{-0.50}$, and $\gamma = 0.87^{+0.05}_{-0.28}$; the production cross section ratio $(K^-p \to \Xi^-K^+)/(K^-n \to \Xi^-K^0)$ is 1.05 ± 0.18; and the Lee and Yang spin test functions are $T_{\frac{1}{2},\frac{1}{2}} = 0.21 \pm 0.13$; $T_{\frac{3}{2},\frac{3}{2}} = 1.06 \pm 0.33$, and $T_{\frac{1}{2},\frac{3}{2}} = 1.83 \pm 0.56$. These results are in agreement with other recent measurements. (A.G.W.)

1314 THE BRANCHING RATIO AND PROTON SPECTRUM OF THE LEPTONIC DECAY $\Lambda^0 \to p + e^- + \bar{\nu}$. C. Baglin (Ecole Polytechnique, Paris), V. Brisson, A. Rousset, et al. p.8-11 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. 1." Bologna, Societa Italiana di Fisica, 1963.

The Ecole Polytechnique heavy liquid bubble chamber was exposed to 1.45-Bev/c K^- mesons from the CERN proton synchrotron. After various selection criteria were applied, 95 events of the type $\Lambda^0 \to p + e^- + \bar{\nu}$ were accepted for measurement and reconstruction in the Λ^0 rest system. The kinematics program generally led to two solutions for each event. The proton kinetic energy and the cosine of the electron-neutrino opening angle are shown in figures. The branching ratio $(\Lambda \to p + e^- + \bar{\nu})/[(\Lambda \to p + \pi^-) + (\Lambda \to n - \pi^0)]$ was found to be $(0.78 \pm 0.12) \times 10^{-3}$. (A.G.W.)

1315 THE DECAY OF HEAVY HYPERFRAGMENTS. p.11-14 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Sccieta Italiana di Fisica, 1963.

In a total of 38,238 interactions in nuclear emulsions exposed to 1.3- or 1.5-Bev/c K^- mesons, 1,698 examples of the production and subsequent decay of a hyperfragment were found. Of these 1,407 represented the decay of a heavy hyperfragment (A = 40 to A = 100), and included 368 D. C. events, 11 mesonic decays, and 1,028 non-mesonic decays. Figures show the distribution of the total energy release in the non-mesonic decays and the range distribution of mesons emitted in the mesonic decays of heavy hyperfragments. From the mesonic decays, a value of 28 ± 2 Mev for the Λ^0-nuclear potential well depth is obtained. A calculation of the Λ^0 neutron to proton stimulation ratio resulted in a value of 2.5. (A.G.W.)

1316 RADIATIVE DECAY OF K^0 MESONS. B. Aubert (Ecole Polytechnique, Paris), L. Behr, J. P. Lowys, P. Mittner, S. Coletti, M. di Corato, and A. Pullia. p.20-1 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

The possible decay $K^0 \rightarrow \pi^+ + \pi^- + \gamma$ was studied in the Ecole Polytechnique heavy liquid bubble chamber. The chamber was exposed to a K^+ beam with an average momentum of 800 Mev/c from the CERN protonsynchrotron. From 27 events analyzed as possible candidates, 5 survived after all cutoffs and selection criteria were applied. The interesting features of the 5 events are tabulated. The experimental value of the branching ratio for radiative $\pi^+\pi^-$ decay was found to be $(2.3 \pm 1.3) \times 10^{-3}$. (A.G.W.)

1317 BRANCHING RATIOS FOR K_2^0 DECAY. p.23-6 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

A high-intensity beam of 1.06 ± 0.04 Bev/c π^- mesons was focussed into a 2-m hydrogen target. K_2^0 mesons were produced in the reactions $\pi^- + p \rightarrow \Lambda^0 + K^0$ and $\pi^- + p \rightarrow \Sigma + K^0$ and their decays were observed in a cloud chamber. The following decay modes were considered: $K_2^0 \rightarrow \pi^+ + \pi^- + \pi^0$; $K_2^0 \rightarrow \pi^\pm + \mu^\mp + \nu$; $K_2^0 \rightarrow \pi^\pm + e^\mp + \nu$; and $K_2^0 \rightarrow \pi^+ + \pi^- + \gamma$. The estimates obtained for the branching ratios were $B_{3\pi} = 0.13 \pm 0.02$, $B_{\pi\mu} = 0.18 \pm 0.03$, and $B_{\pi e} = 0.69 \pm 0.03$. These results disagree with previously reported estimates. Evaluation of possible biases is still in progress. (A.G.W.)

1318 STUDY OF THE π^+ ENERGY SPECTRUM IN THE τ' DECAY MODE. V. Bisi, G. Borreani, R. Cester, et al. (Istituto Nazionale di Fisica Nucleare, Turin). p.30-1 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

The spectrum of the charged pion in the decay $K^+ \rightarrow \pi^+ + 2\pi^0$ was studied in two bubble chambers. The lower part of the spectrum (up to 37 Mev) was obtained from 30,000 pictures of a K^+ beam stopping in the Saclay-CERN 81-cm hydrogen bubble chamber. The upper part of the spectrum was obtained by accepting K^+ stops resulting from interaction of an 800-Mev/c K^+ beam in the Ecole Polytechnique 1-m chamber filled with a propane-freon mixture. The spectrum is shown in a figure. Results to date are compatible with other published results; the experiment is continuing. (A.G.W.)

1319 STUDY OF THREE-BODY LEPTONIC K^+ DECAY MODES. V. Bisi, G. Borreani, R. Cester, et al. (Istituto Nazionale di Fisica Nucleare, Turin). p.32-4 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

Preliminary results on the shape of the μ energy spectrum from $K_{\mu 3}$ decay and the relative frequency of the $K_{\mu 3}$ decay mode are reported. The results were obtained from an analysis of 30,000 pictures taken in the Saclay-CERN 81-cm hydrogen bubble chamber and the K^+ stops of K^+ re-emitted from interactions of an 800 Mev/c K^+ beam in the Ecole Polytechnique 1-m chamber filled with a propane-freon mixture. The muon kinetic energy spectrum is shown in a figure. A value of $4.2 \pm 0.5\%$ was obtained for the branching ratio for $K_{\mu 3}$ decay. (A.G.W.)

1320 EXPERIMENTAL TEST OF THE $\Delta S = \Delta Q$ RULE IN K^0-MESON LEPTONIC DECAY. B. Aubert, L. Behr, M. Bloch, J. P. Lowys, P. Mittner, and A. Orkin-Lecourtois (Ecole Polytechnique, Paris). p.39-46 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

A beam of 800-Mev/c K^+ mesons was directed into a large bubble chamber filled with a propane-freon mixture. The lifetimes of the K^0 mesons produced were measured in two decay modes: (1) $K^0 \rightarrow e^+ + \nu + \pi^-$ and (2) $K^0 \rightarrow e^- + \bar{\nu} + \pi^+$. The ratio of the probability per unit time of K_1^0 leptonic decay to the probability of K_2^0 leptonic decay was determined to be 1.8 ± 1.1. The ratio of the amplitude $\Delta S = -\Delta Q$ to the amplitude $\Delta S = +\Delta Q$ is then $0.15^{+0.11}_{-0.28}$. This result is considered compatible with a non-violation of the $\Delta S = \Delta Q$ rule or a weak violation. (A.G.W.)

1321 PRELIMINARY REPORT ON THE $\Delta Q/\Delta S$ EXPERIMENT. M. Baldo-Ceolin, E. Calimani, S. Ciampolillo, C. Filippi, H. Huzita, F. Mattioli, and G. Miari (Universita, Padua and Istituto Nazionale di Fisica Nucleare, Padua). p.46-8 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

A previous experiment in which the Ecole Polytechnique heavy liquid bubble chamber was exposed to an 800-Mev/c K^+ beam is being repeated. Analysis of the data is incomplete, but preliminary indications are that the ratio of the decay rate of the K_1^0 to the decay rate of the K_2^0 into the leptonic channel is about 7. This result seems to support previous evidence in violation of the $\Delta S = \Delta Q$ rule. (A.G.W.)

1322 METHODS AND PROBLEMS IN THE DYNAMICS OF WEAK INTERACTIONS. A. Pais (Rockefeller Inst., New York). p.64-72 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

A dynamical approach to the theory of weak interactions is presented, in which one starts from Lagrangian field theory and attempts to extract finite information from such a theory. The method is non-perturbative and deals with leptonic processes only. (A.G.W.)

1323 A DETERMINATION OF THE RELATIVE Σ-Λ PARITY. H. Courant (CERN, Geneva), H. Filthuth, P. Franzini, et al. p.73-4 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

To determine the relative Σ-Λ parity, the invariant mass spectrum of Dalitz pairs from the decay of unpolarized Σ^0 hyperons, $\Sigma^0 \rightarrow \Lambda^0 + e^+ + e^-$, was measured. The measurements from 597 events agree very well with the even parity spectrum. The average value of the invariant mass found experimentally was 0.1625 ± 0.0068; the value predicted by theory for even parity is 0.162. (A.G.W.)

1324 EVIDENCE FOR A $\pi\omega$ RESONANCE. Maris Abolins, Richard L. Lander, Werner A. W. Mehlhop, Nguyen huu Xuong, and P. M. Yager (Univ. of California, San Diego, La Jolla). p.81-3 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

Evidence is presented for a $\pi\omega$ resonance at 1.220 Bev with a full width of 0.100 ± 0.020 Bev. A plot of the effective mass distribution of the $\pi^+\pi^-\pi^0$ triplet from the reaction $\pi^+ + p \rightarrow \pi^+ + p + \pi^+ + \pi^- + \pi^0$ clearly shows the ω meson at 785 Mev. After correction for unobserved neutral decay modes of the ω, a cross section of 1.2 ± 0.2 mb at 3.43 Bev/c and 1.06 ± 0.1 mb at 3.54 Bev/c was found for the reaction $\pi^+p \rightarrow \pi^+p\omega$. A plot of mass distribution of the $\pi^+\omega$ pairs of this reaction shows a peak at about 1.22 Bev. This resonance is not observed in the mass spectrum of $4\pi(\pi^+\pi^+\pi^-\pi^0)$ when the $\pi^+\pi^-\pi^0$ triplets are not in the range of the ω mass. (A.G.W.)

1325 SINGLE PION PRODUCTION IN π^+p COLLISIONS AT 800 AND 900 Mev. C. Gensollen, P. Granet, R. Barloutaud, A. Leveque, and J. Meyer (CEN, Saclay, France). p.84-92 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

Results are presented from the analysis of 100,000 bubble chamber pictures of the reactions $\pi^+p \rightarrow \pi^+p$ (elastic), $\pi^+p \rightarrow \pi^+\pi^0p$, and $\pi^+p \rightarrow \pi^+\pi^+n$ at 900-Mev incident energy and $\pi^-p \rightarrow \pi^-p$ (elastic), $\pi^-p \rightarrow \pi^-\pi^0p$, and $\pi^-p \rightarrow \pi^-\pi^+n$ at 800 and 900 Mev. Absolute cross sections for the reactions are tabulated. Data are compared to predictions of Lindenbaum-Sternheimer and Yodh-Olsson. Single pion production is found to be dominated by isobar formation. In π^+p collisions the isobar is produced preferentially in the backward hemisphere; for π^-p interactions at 800 Mev

the π^-n isobar is produced preferentially in the forward direction. The data do not confirm the previously reported T = 1 dipion resonance at 590 Mev either in $\pi^+\pi^0$ or in $\pi^-\pi^0$ and $\pi^-\pi^+$. (A.G.W.)

1326 π^+ + D COLLISIONS AT 650, 750, 850 Mev. E. Pauli (CEN, Saclay, France), A. Muller, R. Barloutaud, L. Carcin, J. Meyer, M. Beneventano, G. Gialanella, L. Paoluzi, and R. Finzi. p.92-8 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

Preliminary results are reported on the analysis of pictures taken with the Saclay deuterium bubble chambers exposed at the synchrotron Saturne to π^+ beams of 650, 750, and 850 Mev. Figures show the following: spectator proton and neutron distribution compared to Hulthen distribution normalized between 120 and 250 Mev; differential cross sections for $\pi^+ + n \rightarrow \pi^+ + n$ and $\pi^+ + p \rightarrow \pi^+ + p$ at several intervals of π^+n and π^+p energies; squared mass distribution of missing neutrals in the reaction $\pi^+ + d \rightarrow p + (p_s) +$ neutrals; total cross sections for reactions $\pi^+ + n \rightarrow p + \eta^0$, $\pi^+ + n \rightarrow p + \pi^0$, and $\pi^+ + n \rightarrow p + \pi^0 + \pi^0$ as a function of the center-of-mass pion-nucleon energy; the angular distribution for η production; and differential cross sections of charge exchange reactions at several intervals of π^+n center-of-mass energy. (A.G.W.)

1327 BRANCHING RATIO OF NEUTRAL DECAY MODES OF η MESON. A. Muller (CEN, Saclay, France), E. Pauli, R. Barloutaud, L. Cardin, J. Meyer, M. Beneventano, G. Gialanella, and L. Paoluzi. p.99-102 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

Pictures taken with the Saclay deuterium bubble chambers exposed to π^+ beams with energies of 650, 750, and 850 Mev were analyzed. Scanning, measurements, and computations showed 8 events that could reasonably be assumed to be $\eta \rightarrow \gamma + \gamma$ events and 34 that could be the sum of $\eta \rightarrow 3\pi^0$ and background events where $2\pi^0$ simulate an η^0 mass. From these a best value of 1.01 ± 0.18 for the ratio of $\eta \rightarrow \gamma + \gamma$ to $\eta \rightarrow \pi^0 + \pi^0 + \pi^0$ was obtained. Results agree with those of other authors and with theoretical predictions. (A.G.W.)

1328 MEASUREMENT OF THE TOTAL CROSS SECTION π-DEUTERIUM. T. Leray, A. Berthon, M. Crozon, and J. L. Narjoux (College de France, Paris). p.102-6 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963. (In French)

The effective total cross sections for meson (π^-) scattering by deuterium were measured at several energies between 420 and 1360 Mev and were compared with the sum of the effective total cross sections for π^+-p interactions. Comparative measurements of the effective cross sections for meson (π^+) scattering by deuterium at 491 to 1063 Mev were made at several solid angles. No violation of the principle of charge symmetry was observed. (D.C.W.)

1329 INVESTIGATION OF d + d INTERACTIONS AT 3 Gev/c. F. Grard, J. Debaisieux, J. Heughebaert, J. Persoons, R. Servrankx, R. Van de Valle, and R. Windmolders (Institut Interuniversitaire des Sciences Nucleaires, Brussels). p.106-7 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

The Saclay 80-cm bubble chamber filled with deuterium was exposed to a deuteron beam of 3 Bev/c at the CERN proton synchrotron. The pictures were scanned for events of the type $d + d \rightarrow {}^4He + \pi^+ + \pi^-$ (+ π^0). So far no events of this type have been definitely identified; two doubtful candidates require further analysis. A search is also being made for events of the type $d + d \rightarrow d + d + \pi^+ + \pi^-$ (+ π^0). (A.G.W.)

1330 THE π^--p REACTION AROUND THE Λ^0K^0 THRESHOLD. R. R. Crittenden (Brookhaven National Lab., Upton, N. Y.), H. J. Martin, and B. Musgrave. p.116-23 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

An attempt was made to look for possible influence on the elastic or inelastic π^--p reaction of opening up the Λ^0K^0 production channel. About 1500 scatterings involving two charged particles were analyzed at each of three beam energies: (1) 10 Mev below Λ^0K^0 threshold, pion momentum 886 Mev/c; (2) at the Λ^0K^0 threshold, pion momentum 896 Mev/c; and (3) 10 Mev above Λ^0K^0 threshold, pion momentum 906 Mev/c. Several examples of the Λ^0K^0 reaction were observed at the highest energy but none at the lower ones. No significant differences between data at the different energies were found. Data on the $\pi^+\pi^-n$ reaction agreed with the isobar model. There was no significant structure in the dipion mass spectrum and no evidence for the existence of the ζ meson. The dipion mass spectrum for the $\pi^-\pi^0p$ reaction showed marked deviation both from the invariant phase space and from the isobar model prediction in the 896- and 906-Mev/c data. A peak was seen around 570 Mev effective mass. (A.G.W.)

1331 ELASTIC K^--p SCATTERING BETWEEN 700 AND 1400 Mev/c. E. F. Beall, W. Holley, D. Keefe, L. T. Kerth, J. J. Thresher, C. L. Wang, and W. A. Wenzel (Univ. of California, Berkeley). p.123-5 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

A variable momentum K^- beam from the Bevatron was used to study the elastic scattering of K^- mesons by protons. A thin-foil cylindrical spark chamber surrounding a liquid hydrogen target was used to record the angles of the incident K^- and of the outgoing secondaries. Approximately 15000 elastic events were grouped to give angular distributions in 16 different momentum bands. The results are shown in figures as center-of-mass differential cross sections. (A.G.W.)

1332 K^--p INTERACTIONS AT 3 Gev/c. [PART] I. E. S. Gelsema (Zeeman Laboratorium, Amsterdam), J. C. Kluyver, A. G. Tenner, et al. p.134-42 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

Preliminary results are presented from analysis of 120,000 pictures of 3-Bev/c K^-p interactions obtained at CERN with the Saclay 81-cm hydrogen bubble chamber. A table shows the 21 types of reactions according to which the 3000 events located were classified and their respective cross sections. The cross sections are similar to those obtained at 2.24 Bev/c. Many of the known resonances appear clearly in the results. Often a resonance is produced in a 2-body process in association either with a particle or with another resonance. All 2-body processes in which the baryon is positive or neutral are produced preferentially with small momentum transfers. Two-body events in which the baryon is negative are much less abundant. This suggests strongly the dominance of peripheral mechanisms in those processes, where the exchange of a doubly charged boson does not occur. (A.G.W.)

1333 K^--p INTERACTIONS AT 3 Gev/c. [PART] II. E. S. Gelsema (Zeeman Laboratorium, Amsterdam), J. C. Kluyver, A. G. Tenner, et al. p.143-6 of ' Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

A scan of Saclay hydrogen bubble chamber pictures of 3-Bev/c K^-p interactions was made, in which all events presenting two or more neutral or charged decays were selected. The results presented are based on analysis of 70% of the data. The reactions observed and their respective cross sections are tabulated. Dalitz plots for the $\Xi K\pi$ and $\Lambda^0K^0K^0$ systems and the angular distribution of Ξ^- and Ξ^* in 2-body reactions are shown. (A.G.W.)

1334 A PRELIMINARY REPORT ON A STUDY OF THE INTERACTIONS OF 3.5 Gev/c K^--MESONS IN HYDROGEN. W. Blair (Univ. of Glasgow), A. Grant, I. S. Hughes, et al. p.146-54 of "Proceedings of the Sienna

International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

The Saclay 81-cm hydrogen bubble chamber was exposed to a separated beam of 3.5-Bev/c K^- mesons. Preliminary results are reported from a study of events with two or more visible strange-particle decays and of a sample of events with one associated strange-particle decay. Forty-two examples of the process $K^- + p \rightarrow \Lambda^0 + K^0 + K^0$ were identified. The dominant feature of the K^0K^0 invariant mass distribution is the peak due to production of the ϕ meson with a mass of 1019.3 ± 1.6 Mev. The numbers of Ξ^- final states identified are tabulated. The figures are used to give a provisional cross section for Ξ^- production of ~160 μb. The 1530-Mev Ξ^* resonance appears to be wider and is a much less dominant feature of the 3-body state than at lower momenta. Some evidence for the production of the 1525-Mev Y_1^* resonance is seen in the distribution of the invariant mass of the $\Sigma^\pm\pi^\pm$ system from the 4-body final state. A plot of the mass distribution for $\Sigma^\pm\pi^\pm$ pairs from the $\Sigma^\pm\pi^\pm\pi^0$ final state shows a remarkably clear peak at the position of the 1405 Y_1^* resonance. The fact that no events that could be interpreted as Ω^- hyperon production could be found indicates an upper limit for the Ω^- production cross section of <3 μb. (A.G.W.)

1335 THE 1660 Mev/c^2 AND Y_1^* RESONANCES. W. A. Cooper (CERN, Geneva), H. Filthuth, A. Fridman, E. Malamud, A. Minguzzi-Ranzi, H. Schneider, E. Gelsema, J. C. Kluyver, and A. G. Tenner. p.154-60 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

Interactions of 1.455-Bev/c K^- mesons with protons in the CERN 32-cm hydrogen bubble chamber were studied, and evidence of a resonance near 1660 Mev/c^2 decaying into 2 and 3 bodies was sought. The evidence presented is based on effective mass plots of $\Sigma^0\pi^0$, $\Sigma^-\pi^+$, $\Sigma^+\pi^-$, $\Lambda\pi$, $\Sigma\pi\pi$, and $\Lambda\pi\pi$. An estimate of $\sigma(Y_1\ (1660)) = 0.27$ mb in reactions leading to Λ^0 is obtained. The branching ratios can be expressed as follows: $K^-p \rightarrow Y + \pi^-$, 0.29 mb; $K^-p \rightarrow Y + \pi^0$, 0.03 ÷ 0.12 mb; $K^-p \rightarrow Y + \pi^+$, 0.02 ÷ 0.22 mb. The results obtained are consistent with a resonance that decays preferentially or exclusively into 3-body positive combinations, and a resonance that decays into 2-body combinations of all three charge states. Among the $\Sigma^\pm\pi^\pm\pi^0$ reactions the two I = 0 resonances, $Y_1^*(1405)$ and $Y_1^*(1520)$, show clearly above a general background. (A.G.W.)

1336 PROPERTIES OF THE $Y_1^*(1358)$ RESONANCE. W. A. Cooper (CERN, Geneva), H. Filthuth, A. Fridman, E. Malamud, H. Schneider, E. S. Gelsema, J. C. Kluyver, and A. G. Tenner. p.160-6 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

A study of the properties of the Y_1^* (1385) resonance is based on 582 events of the type $K^-p \rightarrow \Lambda^0\pi^+\pi^-$ and 709 events of the type $K^-p \rightarrow \Lambda^0\pi^+\pi^-\pi^0$ formed in interactions of 1.455-Bev/c K^- mesons in the CERN 30-cm hydrogen bubble chamber. The Y_1^* shows clearly as two bands on the Dalitz plot for the reaction $K^-p \rightarrow \Lambda^0\pi^+\pi^-$. On a plot of effective mass distributions, the Y_1^- appears wider than the Y_1^+, and the average masses of the two seem different. Possible interferences that could account for the apparent mass difference are considered. The Y^{*-} and Y^{*+} production distributions are similar to each other. An apparent significant difference in the decay of the Y^+ and Y^- is discussed, but no definite conclusions are drawn. (A.G.W.)

1337 MEASUREMENT OF THE ω^0 AND η^0 BRANCHING RATIOS AND A STUDY OF THE REACTION $K^- + p \rightarrow \bar{K}^0 + n$. B. Buschbeck-Czapp (Universitat, Vienna), I. Wacek, W. A. Cooper, A. Fridman, E. Malamud, G. Otter, E. Gelsema, and A. Tenner. p.166-70 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

Interactions of 1.455-Bev/c K^- mesons with protons in the CERN 30-cm hydrogen bubble chamber were studied. In measuring the ω^0 and η^0 branching ratios, both 0-prong and 2-prong events were treated in the same way by demanding only a Λ^0 decay fit. The ratio of $\eta \rightarrow$ neutrals to $\eta \rightarrow \pi^+\pi^-\pi^0$ was found to be 3.3, a value slightly higher than that found by other groups. An upper limit $\omega \rightarrow \pi^+\pi^- < 0.09\ \omega \rightarrow \pi^+\pi^-\pi^0$ was obtained. A study of the reaction $K^- + p \rightarrow \bar{K}^0 + n$ gave a charge exchange cross section of 1.95 ± 0.20 mb. (A.G.W.)

1338 A NEW METHOD OF SPIN ANALYSIS APPLIED TO THE K^*. E. S. Gelsema (Zeeman Laboratorium, Amsterdam), J. C. Kluyver, A. G. Tenner, W. A. Cooper, A. Fridman, and E. Malamud. p.170-3 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

The reaction $K^- + p \rightarrow \bar{K}^0 + \pi^- + p$ was studied with 1.455-Bev/c K^- mesons in the 32-cm hydrogen bubble chamber. The Dalitz plot showed a strong production of K^* with a mass of 888 ± 3 Mev and a width of 45 ± 5 Mev. The total cross section for the reaction was 2.0 ± 0.3 mb. In a study of the spin of the K^*, a sample of 63 events was defined by the two criteria 820 Mev < $M_{K\pi}$ < 950 Mev and $|\cos\theta^*| > 0.85$. For those events the distribution of the angle between the K^0 and the incoming K^- in the K^* rest frame was clearly anisotropic. For the same events the distribution of the angle β ($\cos\beta = \vec{K}^0 \cdot \vec{K}^*$ in the rest frame) was also anisotropic. From these observed anisotropies it is concluded that $J_{K^*} \geq 1$. The results do not permit conclusion as to the upper limit of the spin of K^*. (A.G.W.)

1339 PRELIMINARY RESULTS ON $\Xi^- + K^\delta + n\pi$ FINAL STATES PRODUCED BY 3.5 Gev K^-. A. Halsteinslid, (Bergen Univ., Norway), R. Moellerud, J. M. Olsen, et al. p.173-8 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

Previously reported negative results of a search for the predicted Ω^- or Z^- hyperon and for possible I = ½ resonances in the $\Xi^-\pi^-$ system produced by a 3.5-Bev/c K^- beam in the CERN 1.15-m freon bubble chamber are confirmed. It is concluded that the Ω^- or Z^- hyperon probably has a production cross section less than ~3 μb/nucleon for decay involving Ξ^-. Further study of the peak between 1.7 and 1.8 Bev in the $I_Z = 1/2$, $\Xi^-\pi^\delta$ mass distribution suggests the existence of a possible new resonant state of the Ξ. If this state does exist its mass is ~1.77 Bev, its width probably less than 80 Mev, and its isospin is ½. (A.G.W.)

1340 THE PARITY OF THE $Y_1^*(1660)$ RESONANCES. M. Taher-Zadeh, D. J. Prowse, P. E. Schlein, W. E. Slater, C. H. Stork, and H. K. Ticho (Univ. of California, Los Angeles). p.178-82 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

The reaction $K^- + d \rightarrow p + \pi^- + \Lambda$ initiated by K^- mesons of incident momenta 600, 760, and 850 Mev/c in the LRL 15-in. bubble chamber filled with deuterium was investigated. Selection procedures yielded 550 events suitable for use in analyzing the parity of the Y_1^* (1660) resonances. The data are consistent with a $D_{\frac{5}{2}}$ resonance, but the determination is not regarded as firm. (A.G.W.)

1341 SOME RESULTS ON 3 Gev/c K^+ INTERACTIONS IN HYDROGEN. M. Ferro-Luzzi, R. George, J. Goldschmidt-Clermont, V. Henri, B. Jongejans, D. Leith, G. Lynch, F. Muller, and J. M. Perreau (CERN, Geneva). p.182-9 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

The Saclay 81-cm hydrogen bubble chamber was exposed to a separated beam of K^+ mesons. The beam momentum was 2.965 ± 0.015 Bev/c, and the estimated π contamination averaged 6%. Cross sections for 2-prong, 2-prong V^0, 4-prong V^0, and 4-prong events are listed. A specific search for reactions producing neutral hyperons resulted in the following cross sections: $\sigma(\Lambda^0K^+K^+) \simeq 24$ μb and $\sigma(\Sigma^0K^+K^+) \simeq 6$ μb. A scatter diagram of the center-of-mass emission angle of the hyperon and of the mass of the

K^+K^+ system shows that in general the hyperon goes strongly backward. (A.G.W.)

1342 PRODUCTION MECHANISMS OF K* AND N* BY 3 Gev/c K^+ ON PROTONS. M. Ferro-Luzzi, R. George, Y. Goldschmidt-Clermont, V. P. Venri, B. Jongejans, D. Leith, G. Lynch, F. Muller, and J. M. Perreau (CERN, Geneva). p.189-95 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

In analysis of the 3-Bev/c K^+ interactions in the 81-cm Saclay hydrogen bubble chamber, the production mechanisms for the following three reactions were studied: (1) $K^+p \rightarrow N^*_{33}K^0$; (2) $K^+p \rightarrow pK^*$; and (3) $K^+p \rightarrow N^*_{33}K^*$. It is demonstrated that all three reactions are consistent with the hypothesis that the mechanism of production is single meson exchange, that reaction three is determined by the exchange of a pion, and that both reactions one and two are dominated by the exchange of a vector meson. (A.G.W.)

1343 THE BRANCHING RATIO $(\Sigma^- + p \rightarrow \Sigma^0 + N)/(\Sigma^- + p \rightarrow \Sigma^0$ OR $\Lambda^0 + N)$. R. Carrara, M. Cresti, A. Grigoletto, S. Limentani, L. Peruzzo, R. Santangelo, and R. B. Willmann (Universita, Padua). p.196-8 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

Pictures were taken with the 81-cm hydrogen bubble chamber exposed to a separated K^- beam from the CERN proton synchrotron. Measurements of 524 Σ^- captures in hydrogen giving rise to hyperons via the reactions $\Sigma^- + p \rightarrow \Lambda^0 + N$ and $\Sigma^- + p \rightarrow \Sigma^0 (\rightarrow \Lambda^0 + \gamma) + N$ resulted in a branching ratio of 0.40 ± 0.03. This suggests a value of the coupling constant $f_{\Sigma\Sigma}$ somewhere between the theoretical predictions for global symmetry and for unitary symmetry as can be given by an admixture of F and D couplings. (A.G.W.)

1344 ON THE $(\Sigma\pi)$ RESONANCE AT 1405 Mev. p.199-200 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

From about 17,000 interactions at rest with emulsion nuclei, 271 $\Sigma\pi$ events were selected. The distribution of the resultant momentum $p^* = |\vec{p}_\Sigma + \vec{p}_\pi|$ for the 271 events shows no evidence of a resonance of narrow width at 1450 Mev. (A.G.W.)

1345 PRODUCTION OF MULTIPION FINAL STATES BY 3.2 Gev/c π^- MESONS. Suh Urk Chung, Orin I. Dahl, Richard I. Hess, George R. Kalbfleisch, Janos Kirz, Donald H. Miller, and Gerald A. Smith (Univ. of California, Berkeley). p.201-4 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

Almost 7000 events with four charged prongs in the final state were processed in a study of π^-p interactions at 3.24 Bev/c. The five most common reactions and their cross sections are listed. Resonance production in 5-body final states is abundant. Production of $N^*_{\frac{1}{2}}(1238)$ is observed in favorable charge states. The cross section for the reaction $\pi^- + p \rightarrow \pi^- + p + \omega^0$ is estimated to be 0.3 mb. The mass spectrum of the $\omega\pi$ system shows a peak at around 1200 Mev. Theories concerning the $\omega\pi$ system are discussed briefly. (A.G.W.)

1346 Σ^0-Λ^0 RELATIVE PARITY. C. Alff (Columbia Univ., New York), U. Nauenberg, M. Nussbaum, J. Ratau, J. Schultz, J. Steinberger, L. Kirsch, R. Plano, D. Berley, and A. Prodell. p.205-6 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

The Dalitz pair spectrum from the decay $\Sigma^0 \rightarrow \Lambda^0 + e^+ + e^-$ was studied in order to obtain the Σ^0-Λ^0 relative parity. The Columbia-Brookhaven 30-in. hydrogen chamber was placed in the separated low-momentum K^- beam at the AGS, and 284 decays of this type were observed. The data obtained fit the expected spectra for even parity much better than they do the odd one. This result agrees with that of other investigators. (A.G.W.)

1347 $\pi^+ + p$ INTERACTIONS AT 1.6 Gev/c. A. Berthelot (CEN, Saclay), A. Daudin, M. A. Jabiol, C. Kochowski, C. Lewin, A. Rogozinski, S. Mongelli, A. Romano, P. Waloschek. p.228-32 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

Results from the analysis of ~6000 2-prong events observed in a 50-cm hydrogen bubble chamber are presented. The following cross sections were obtained: (1) $\pi^+ + p \rightarrow \pi^+ + \pi^0 + p$, 7.4 ± 0.2 mb; (2) $\pi^+ + p \rightarrow \pi^+ + \pi^+ + n$, 3.3 ± 0.2 mb; (3) $\pi^+ + p \rightarrow \pi^+ + X^0$, 3.7 ± 0.2 mb; (4) $\pi^+ + p \rightarrow \pi^+ + \pi^+ + n + X^0$, 1.8 ± 0.1 mb. The $\pi^+\pi^0$ system observed in reaction (1) presents the characteristic features of the ρ resonance. The effective mass spectrum of the $p\pi^+$ system in reaction (1) presents a peak at 1230 Mev, which remains when ρ^+ events are removed. The reaction $\pi^+ p \rightarrow N^{*++} + \eta$ is observed in events of type (3). The mass spectrum obtained for reaction (2) is in agreement with phase space giving no indication for a particular structure of the T = 2 pion-pion system. Partial results from a study of the reaction $\pi^+ + p \rightarrow \pi^+ + p + \gamma$ give a branching ratio $p\pi^+\gamma/p\pi^0\pi^+$ less than 5%. (A.G.W.)

1348 MULTIPLE PION PRODUCTION IN π^--p INTERACTIONS AT 2.75 Gev/c. J. Alitti (Rene of Laboratoire de Physique Corpusculaire a Haute Energie, Saclay, France), J. P. Baton, A. Berthelot, et al. p.232-8 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

The 81-cm Saclay hydrogen bubble chamber was exposed to a beam of 2.75 Bev/c at the CERN proton synchrotron. The following cross sections were obtained: (1) $\pi^-p \rightarrow \pi^-p\pi^+\pi^-$, 1.7 mb; (2) $\pi^-p \rightarrow \pi^-p\pi^+\pi^-\pi^0$, 1.4 mb; (3) $\pi^-p \rightarrow \pi^-\pi^+\pi^+\pi^-N$, 0.6 mb. In reaction (1) abundant production of N^{*++} was observed with a cross section of 0.6 mb. Neither ρ^0 nor $p\pi^-$ isobar production was observed for events in the $p\pi^+$ isobar band, but the distribution of the squared momentum transfer to the isobar showed possible one-pion exchange mechanism. Considerable ρ^0 production was observed for events outside the N^{*++} isobar band, and the $p\pi^-$ mass distribution showed enhancements at mass values corresponding to the $N^{*0}_{\frac{3}{2},\frac{3}{2}}$ isobar and $N^{*0}_{\frac{3}{2},\frac{1}{2}}$ isobar. In reaction (2) the $\pi^+\pi^-\pi^0$ mass distribution showed a strong peak at 780 Mev corresponding to ω production and a small peak at 550 Mev that can be attributed to η production. The $p\pi^-$ mass distribution for ω events showed two peaks at mass values corresponding to $N^{*0}_{\frac{3}{2},\frac{3}{2}}$ and $N^{*0}_{\frac{3}{2},\frac{1}{2}}$ isobars. In reaction (3) the N^{*-}_{33} isobar is produced in about 30% of the interactions. There is some indication in the $\pi^-\pi^+$ effective mass spectrum for the production of the ρ^0 meson. There appears to be a departure from the phase space prediction for the 4-pion effective mass distribution in the form of a peak between 1380 and 1420 Mev. (A.G.W.)

1349 SINGLE MESON PRODUCTION IN π^+-p INTERACTIONS AT 2.75 Gev/c. N. Armenise (Istituto di Fisica, Bari, Italy), B. Ghidini, S. Mongelli, et al. p.239-43 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

The Saclay 81-cm hydrogen bubble chamber was exposed to a beam of 2.75 Bev/c π^+ mesons at the CERN proton synchroton. Cross sections for the reactions $\pi^+ + p \rightarrow p\pi^+\pi^0$ (1) and $\pi^+ + p \rightarrow \pi^+\pi^+n$ (2) were found to be 3.3 ± 0.5 and 2.4 ± 0.8 mb, respectively. The outstanding features observed in reaction (1) were ρ^+ and N^{*++} production. The cross section for ρ^+ production is estimated to be 22% of that for reaction (1). The $p\pi^+$ effective mass spectrum showed evidence for production of N^{*++} isobar in about 7% of the events of reaction (1). The effective mass spectrum of the $\pi^+\pi^+$ system (T = 2) observed in reaction (2) does not exhibit any structure and is comparable with phase space for all values of Δ^2 to the neutron. The Δ^2 distribution is peaked at low values, characteristic of peripheral interactions and is in good agreement with one-pion exchange. (A.G.W.)

1350 ANTIPROTON-PROTON LOW ENERGY CROSS SECTIONS. U. Amaldi, Jr. (CERN, Geneva), B. Conforto, G. Fidecaro, et al. p.243-8 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

The Saclay 81-cm hydrogen bubble chamber was exposed to the low-energy separated antiproton beam from the CERN proton synchrotron in an attempt to measure $\bar{p}$-p cross sections below 180 Mev with high energy resolution and statistical accuracy. Figures show annihilation and scattering cross sections as functions of energy. Comparisons are made with other results and with theoretical predictions. The theoretical cross section predicted by Ball and Chew is too low by about 20 mb, but the general behavior as a function of energy is compatible with the data obtained. A smooth energy dependence of the cross section cannot be excluded. The angular distributions from 4200 scatterings suggest a dominating diffraction-like behavior related to the strong annihilation interaction. (A.G.W.)

1351 ELASTIC SCATTERING OF ANTIPROTONS BY PROTONS AT LOW ENERGIES. A. Hossain and M. A. Shaukat (Atomic Energy Centre, Lahore, Pakistan). p.248-51 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

A stack of 100 pellicles of Ilford K-5 emulsion was exposed to a separated beam of 725-Mev/c antiprotons at the CERN proton synchrotron. The events were analyzed and the values of the elastic scattering cross sections were computed in the three energy intervals 60-40, 40-20, and 20-5 Mev. The corrected values obtained were 86.5 ± 16.3, 89.0 ± 14.8, and 93.7 ± 20.5 mb, respectively, for the three intervals. There appears to be some agreement between the observed angular distributions for the three intervals and the expected distributions based on the optical model in the 60-40 and 40-20 intervals. (A.G.W.)

1352 ELASTIC SCATTERING AND POLARIZATION IN ANTIPROTON-PROTON COLLISIONS AT 4 Bev/c. O. Czyzewski (CERN, Geneva), B. Escoubes, Y. Goldshmidt-Clermont, M. Guinea-Moorhead, T. Hofmokl, D. R. O. Morrison, S. de Unamuno, E. B. Burkard, and P. Soding. p.252-63 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

Results obtained at 4 Bev/c in a study of 2-prong interactions observed in the 81-cm Saclay hydrogen bubble chamber exposed to the separated antiproton beam of the CERN proton synchrotron are presented. Differential cross sections for elastic scattering at small angles are shown in figures and compared with proton-proton scattering. The diffraction peak is much narrower than for proton-proton collisions. At large angles the ratio of the differential cross section to its forward value is lower by a factor of 10 for antiprotons than for protons. The total cross section was found to be 71.0 ± 1 mb; the elastic cross section was 19.75 ± 0.73 mb. Comparison with other results indicates that the ratio of the elastic cross section to the total cross section tends to decrease as the energy increases. A study of antiprotons showing two successive elastic scatterings showed no indication of polarization in such interactions. (A.G.W.)

1353 PROTONIUM ANNIHILATION INTO PIONS. M. Cresti (Universita, Padua), A. Grigoletto, S. Limentani, et al. p.263-71 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

Results are presented from a study of pion resonances in ~10000 events produced in the Saclay 81-cm hydrogen bubble chamber by a beam of slow antiprotons from the CERN synchrotron. The branching ratio for the reaction $\bar{p} + p \rightarrow 2\pi^+ + 2\pi^-$ was found to be 0.054 ± 0.003 for 11% of all 4-prong events. The only resonance observed in this reaction was the ρ^0. The absolute branching ratio for the reaction $\bar{p} + p \rightarrow 2\pi^+ + 2\pi^- + \pi^0$ was found to be 0.226 ± 0.007 or 46% of all 4-prong events. Effective mass distribution plots for this reaction show strong production of the ω and ρ mesons and a small degree of η production. Some evidence was found for the process $\bar{p} \rightarrow p \rightarrow \omega^0 + \rho^0$. Six-prong events represent 4.1% of all annihilations. The ω is strongly produced in the reaction $\bar{p} + p \rightarrow 3\pi^+ + 3\pi^- + \pi^0$. The ω peak appears to be wider than the experimental resolution. (A.G.W.)

1354 TWO PRONG INELASTIC INTERACTIONS ANNIHILATIONS AND CHARGE EXCHANGE OF 3.0 Gev/c AND 4.0 Gev/c ANTIPROTONS IN HYDROGEN. O. Czyzewski, B. Escoubes, Y. Goldschmidt-Clermont, M. Guinea-Moorhead, T. Hofmokl, R. Lewisch, D. R. O. Morrison, M. Schneeberger, and S. de Unamuno (CERN, Geneva). p.271-82 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

Photographs from the 81-cm Saclay hydrogen bubble chamber operating in 3.0 Bev/c and 4.0 Bev/c separated antiproton beams were used to study 2-prong inelastic and annihilation processes in order to investigate the reaction mechanism and the possible role of resonance. Values are given for the cross sections of the different channels and compared with results at lower incident momenta obtained in other experiments. Evidence is presented for the formation of the $(^3/_2, ^3/_2)$ resonances in the pion-nucleon and pion-antinucleon systems. The results are analyzed in terms of the one-pion exchange model using parameters obtained from proton-proton cross sections, and the importance of the final state NN interaction is discussed. Cross section estimates are given for annihilations into two pions or two kaons only. In two-prong annihilations the negative pions are found to be peaked forward and the positives to be peaked backward in the center of mass. From an analysis of antineutron stars, it was possible to study the antiproton charge exchange angular distribution, and this is compared with that for elastic scattering. (auth)

1355 EVIDENCE FOR A (K^0_1 $K^\pm$ $\pi^\mp$) RESONANCE NEAR 1410 Mev IN $p + \bar{p} \rightarrow K\bar{K}3\pi$ ANNIHILATIONS AT REST AND STUDY OF THE $p\bar{p} \rightarrow K\bar{K}\pi$ ANNIHILATIONS AT REST. R. Armenteros (CERN, Geneva), D. N. Edwards, T. Jacobsen, et al. p.287-91 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

A study of the antiproton annihilations at rest of the type $K\bar{K}3\pi$ in the Saclay 80-cm hydrogen bubble chamber shows a significant bump above phase space in the 1370- to 1450-Mev energy range in the following: (1) the effective mass spectrum of total charge zero systems $K^0_1K^\pm\pi^\mp$ (where K^0_1 means K^0_1 decaying in $\pi^+\pi^-$) of events of the type $K^0_1K^\pm\pi^\mp\pi^+\pi^-$; (2) the $K^0_1K^\pm\pi^\mp$ effective mass spectrum of $K^0_1K^\pm\pi^\mp(M)$ events (where M means missing mass greater than one π^0 mass; and (3) the $\{K^0\}$ $K^\pm\pi^\mp$ effective mass spectrum of the events $\{K^0\}$ $K^\pm\pi^\mp\pi^+\pi^-$ where $\{K^0\}$ means K^0 not seen. The existence of a resonance in the $K\bar{K}\pi$ system near 1410 Mev is thus strongly suggested. In a study of the $p\bar{p} \rightarrow K\bar{K}\pi$ annihilations at rest, the only charge configurations observed are the $K^0_1K^\pm\pi^\mp$ and the $K^0_1K^0_1\pi^0$. Dalitz plots for both are shown and possible interpretations are discussed. (A.G.W.)

1356 THE LIFETIME OF THE ω MESON. N. Gelfand (Columbia Univ., New York), D. Miller, N. Nussbaum, J. Ratau, J. Schultz, J. Steinberger, T. H. Tan, L. Kirsch, and R. Plano. p.293-6 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fiscia, 1963.

Approximately 400,000 antiprotons were stopped in the Columbia-BNL 30-in. hydrogen chamber and 119 examples of the reaction $\bar{p} + p \rightarrow K^+ + K^- + \pi^+ + \pi^- + \pi^0$ were found with both K's stopping in the chamber. The larger part of this reaction proceeds through the ω channel: $\bar{p} + p \rightarrow K^+ + K^- + \omega$, $\omega \rightarrow \pi^+ + \pi^- + \pi^0$. From these events the mass of the ω was determined to be 784.0 ± 0.9 Mev, its width, 9.5 ± 2.1 Mev, and the corresponding ω lifetime, $0.69 \pm 0.15 \times 10^{-22}$ sec. The partial decay rates are for $\omega \rightarrow \pi^+ + \pi^- + \pi^0$, $P_1 = 1.30 \pm 0.3 \times 10^{+22}$ sec^{-1} and for $\omega \rightarrow$ neutrals, $P_2 = 0.15 \pm 0.07 \times 10^{+22}$ sec^{-1}. (A.G.W.)

1357 MASS AND WIDTH OF THE ω^0-MESON AND BRANCHING RATIOS $\frac{\omega \to \text{NEUTRALS}}{\omega \to \pi^+\pi^-\pi^0 \text{ OR } \gamma}$, $\frac{\omega \to 2\pi}{\omega \to \pi^+\pi^-\pi^0 \text{ OR } \gamma}$. R. Armenteros (CERN, Geneva), D. N. Edwards, T. Jacobsen, et al. p.296-301 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

A run with the Saclay 81-cm hydrogen bubble chamber at the CERN proton synchrotron provided a substantial number of events corresponding to the reaction $\bar{p}p \to K^+K^-\pi^+\pi^-\pi^0$. Since this reaction is strongly dominated by ω production, determination of the mass and width is possible from the kaon momenta. As yet no quantitative fit to the data has been attempted, but by a trial and error method values of 784 Mev for the mass and 9 Mev for the width of the ω were obtained. The branching ratio ($\omega \to$ neutrals/$\omega \to \pi^+\pi^-\pi^0$ or γ) was found to be $17 \pm 4\%$. An upper limit of 5% for the branching ratio ($\omega \to \pi^+\pi^-/\omega \to \pi^+\pi^-\pi^0$ or γ) is given. (A.G.W.)

1358 STUDY OF $Y\bar{Y}$ PRODUCTION IN TWO BODY FINAL STATES BY 3.0, 3.6, AND 4.0 Gev/c ANTIPROTONS IN HYDROGEN. B. Musgrave (Univ. of Birmingham, Eng.), G. Petmezas, L. Riddiford, et al. p.301-11 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

The 80-cm Saclay liquid hydrogen bubble chamber was exposed to antiprotons of 3.0, 3.6, and 4.0 Bev/c from the CERN proton synchrotron. Three events yielding $\bar{\Xi}^-\bar{\Xi}^-$ were observed at 3.0 Bev/c, and none at 3.6 and 4.0 Bev/c. Production cross sections are 1 to 3 μb at 3.0 Bev/c and <1 μb at 3.6 and 4.0 Bev/c. It is concluded that the $\bar{p} + p \to \bar{\Sigma}^+ + \Sigma^+$ interaction is consistent with a peripheral process. The Δ^2 distribution for small Δ^2 is not compatible with a K exchange. The fact that the $\bar{\Sigma}^+$ production cross section is 3 times smaller than that of the Σ^+ indicates that the production mechanisms for Σ^+ and Σ^- are different. Limits for the production cross section of $\Sigma^0\bar{\Sigma}^0$ were found to be $1\ \mu b < \sigma_0 < 19\ \mu b$. Cross sections for production of the following final states at all three energies are tabulated: $\Lambda^0\bar{\Lambda}^0$, $\Lambda^0\bar{\Sigma} + \Sigma^0\bar{\Lambda}^0$, $\Sigma^0\bar{\Sigma}^0$, $\Sigma^+\bar{\Sigma}^+$, $\Sigma^-\bar{\Sigma}^-$, and $\Xi^-\bar{\Xi}^-$. It is noted that the cross sections for 2-body final states show a decrease with increasing p momentum. The $\bar{\Sigma}^-$ and $\bar{\Xi}^-$ production cross sections are considerably smaller and their angular distribution markedly different than for the other 2-body final states. The experimental branching ratios between various final states are not incompatible with theoretical predictions. (A.G.W.)

1359 STUDY OF $Y\bar{Y}$ PRODUCTION IN THREE AND FOUR BODY FINAL STATES BY 3, 3.6 AND 4 Gev/c ANTIPROTONS IN HYDROGEN. B. Musgrave (Univ. of Birmingham, Eng.), G. Petmezas, L. Riddiford, et al. p.312-22 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

The 81-cm Saclay hydrogen bubble chamber was exposed to antiprotons of 3, 3.6, and 4 Bev/c at the CERN proton synchrotron. Cross sections for $\bar{p}p$ interactions leading to $Y\bar{Y}\pi$ and $Y\bar{Y}\pi\pi$ are tabulated. These cross sections seem to remain constant in the region from 3 to Bev/c. The $\bar{Y}_1^*(1385)$, $\bar{Y}_{01}^*(1405)$, and $\bar{Y}_{02}^*(1520)$ resonances and their charge conjugates are produced frequently in all the reactions studied. In the reactions $\bar{p}p \to \bar{\Sigma}^0\pi^\pm\Sigma^\mp$ ($\bar{\Sigma}^0\pi^\mp\Sigma^\pm$) the cross sections for Y*'s production are considerably lower than for the other reactions. The interactions $\bar{p}p \to \bar{Y}Y\pi$ and $\bar{p}p \to \Lambda\bar{\Lambda}\pi\pi$ seem to proceed predominantly by a peripheral type mechanism with the exchange of a system of charge 0 or 1 (but not 2) and strangeness 1. The latter reaction may contain a significant contribution from a different production mechanism as is indicated by the occurrence of the $\bar{p}p \to Y_1^{*-} + Y_1^{*+}$. (A.G.W.)

1360 ANALYSIS OF 4 Gev/c PROTON PROTON INTERACTIONS. II. THREE PION PRODUCTION IN (PP) INTERACTIONS. J. Kidd, S. Ratti, A. Sichirollo, and G. Vegni (Universitâ, Milan and Istituto Nazionale di Fisica Nucleare, Milan). p.348-52 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

Inelastic proton-proton collisions of the type $p + p \to 2N + 3\pi$ were studied in the 81-cm Saclay hydrogen bubble chamber exposed to a proton of 4 Bev/c at CERN. Plots of the effective mass of the $\pi^+\pi^-\pi^+$ combination indicate that the reaction $p + p \to p + p + \pi^+ + \pi^- + \pi^+$ is strongly dominated by the contemporary formation of the two possible nucleon-pion states in the pure isospin $T = 3/2$. In plots of the effective mass of the $\pi^+\pi^-\pi^0$ combination, the contribution of the ω formation to the interactions is not negligible, and it seems to overcome the formation of the $N_3^*(p,\pi^+)$ isobar. Nucleon momentum distributions in the center-of-mass system indicate that the mechanism at work in the ω production is practically the same as that responsible for 3-pion production (probably a central collision). (A.G.W.)

1361 PION-PION SCATTERING AT LOW AND HIGH ENERGIES. B. H. Bransden, P. G. Burke, J. W. Moffat, R. G. Moorhouse, and D. Morgan. p.356-62 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

Calculations are reported on pion-pion scattering using the strip approximation with a cut-off. Starting from an assumed form for the low partial waves, the spectral functions are calculated and two classes of predictions are made: (1) D and higher elastic partial waves and low-energy inelastic partial waves are calculated; (2) Regge trajectories are deduced. Solutions are found for which the I = 0 trajectory passes approximately through $\alpha = 1$ at $t = 0$ and the I = 1 trajectory is consistent with the ρ resonance. The resonance is only reproduced when a substantial I = 0 D wave contribution at high energies is included. The predictions for diffraction scattering are not satisfactory, and reasons are given for this. (auth)

1362 SU_3-SYMMETRY AND THE STRUCTURE OF VECTOR MESONS. J. Kalckar (NORDITA, Copenhagen). p.362-5 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

The structure of the composing two-particle states of the two hitherto known vector meson multiplets, the singlet and the octuplet, is considered. The considerations are primitive, but the results obtained so far point to the existence of two new vector meson multiplets, classified as the (30) and (03) representation of SU_3. A rough estimate indicates the possibility of obtaining an average mass for the decuplets that is large compared to that of the vector meson octuplet. (A.G.W.)

1363 POLARIZATION OF THE RECOIL PROTON IN ELASTIC ELECTRON-PROTON OR MUON-PROTON SCATTERING AND ASYMMETRY OF THE RECOIL PROTON IN MUON-PROTON SCATTERING WITH POLARIZED INCIDENT MUONS. F. Guerin and C. A. Piketty (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). p.371-6 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

An isobaric model was used in calculating the polarization of the recoil proton in elastic electron-proton or muon-proton scattering. The results in each case are plotted as a function of the cosine of the center-of-mass scattering angle for various laboratory momenta of the incident particles (electron or μ meson). Results of the two cases are similar. The asymmetry of the recoil proton in muon-proton scattering with polarized incident muons was also calculated and plotted as a function of the center-of-mass scattering angle for different laboratory momenta of the incident μ meson. No great change occurs in the shape of the curves as the momenta of the incident meson increases. (A.G.W.)

1364 WEAK CURRENTS AND UNITARY SYMMETRY. M. Gourdin (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). p.377-9 of "Proceedings of the

Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

The simplest generalization of the octuplet model for elementary particle interactions including observed weak currents is given. It is an eightfold way based on the orthogonal group in an eight-dimensional euclidian space, SO(8). (A.G.W.)

1365 INFLUENCE OF THE RELATIVISTIC CORRECTIONS ON THE NEUTRON CHARGE FORM FACTOR DETERMINATION. J. Tran Thanh Van (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). p.379-83 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

The neutron charge form factors are computed in a relativistic formulation from deuteron scattering. A separable interaction model is used to calculate the static properties and the structure functions of the deuteron. Two kinds of relativistic corrections are made: (1) a reduction of the charge structure function appears to be due to the effect of contraction of the final wave function and to the retardation; (2) an increase of the change structure function with the transfer momentum is due to the presence of a deuteron quadrupole moment. It is concluded that a relativistic treatment gives an increase to the cross section when compared to the nonrelativistic calculation, consequently gives a decrease of isoscalar nucleon form faotor, and finally leads to a lower neutron charge form factor. (A.G.W.)

1366 COMPLEX ANGULAR MOMENTUM AND MANY-PARTICLE STATES. J. Gunson (Univ. of Birmingham, Eng.). p.383-6 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

A sequence of theorems, without proofs, forming part of an investigation into the problem of scattering involving external Regge particles is presented. The natural definition of the corresponding scattering amplitudes is in terms of the residues at Regge poles in many-particle amplitudes involving physical external particles. A rigorous analysis of the problem of defining suitable interpolatory function in complex angular momentum and the uniqueness of such a definition is given. The procedure of physical region partial wave projection is used. In three momentum transfer variables, the many-particle amplitude is treated as a function defined on the manifold of the rotation group SO(3). Under the analyticity hypotheses, this is extended to a domain on the corresponding complex group and in certain cases the spectrum of singularities can be made to lie within a subgroup G, which is locally isomorphic to SL(2,C). For these cases, the transformation to the complex angular momentum plane may be regarded as a Laplace transform on the group SL(2,S). (A.G.W.)

1367 THE T = 0, T = 1 AND T = 2 π-π INTERACTIONS. G. C. Oades (London Univ.). p.388-93 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

In calculations concerning the T = 0 and T = 2 pion-pion interactions, the imaginary parts of the inverse amplitudes are approximated by their branch point behavior. The resulting s-wave phases for the two states are shown in a figure. In the case of the T = 2 state, a method similar to that used by Donnachie and Hamilton (University College, London preprint 1963) in a calculation of the π-N $\frac{3}{2}$, $\frac{3}{2}$ resonance is used. It is concluded that the values obtained for the resonance energy agree very well with experimental values, but the widths obtained are too large. (A.G.W.)

1368 THE $(\frac{3}{2},\frac{3}{2})$ PION-NUCLEON RESONANCE. A. Donnachie (London Univ.). p.393-9 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

The results of a calculation of the $(\frac{3}{2},\frac{3}{2})$ π-N resonance using a new variational technique for solving partial wave dispersion relations are presented. The resonance is found to be at 206 Mev, the width at half height 120 Mev, and the scattering length 0.208. The self-consistency of the solution is good, and the solution agrees with the experimental values to within the experimental error or a little more. (A.G.W.)

1369 PION-NUCLEON PHASE SHIFT ANALYSIS. B. T. Feld and D. L. Roper (Massachusetts Inst. of Tech., Cambridge). p.400 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

An analysis was carried out of all available pion-nucleon interaction data at the pion kinetic energy of 310 Mev. Some of the fits previously obtained are markedly improved by inclusion of an ABC-pole with $l_{max} = 4$. Preliminary results of an energy-dependent analysis in the energy range 0-700 Mev show a marked preference for D-$\frac{3}{2}$ as the state responsible for the 600-Mev, T $\frac{1}{2}$ resonance. The analysis also indicates a very strongly absorbing P-$\frac{1}{2}$, T $\frac{1}{2}$ state, the real part of whose phase shift is already quite large and increasing at the end of this energy range. (A.G.W.)

1370 SOFT VECTOR MESON RADIATION AS A TEST OF THE GAUGE THEORY OF STRONG INTERACTIONS. K. E. Eriksson and S. A. Yngstroem (Uppsala Univ.). p.401-3 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

It is assumed that the ω-meson field mediates the interaction between baryonic charges. Then — in analogy with bremsstrahlung in electrodynamics — the gauge theory of strong interactions has the consequence that soft-meson radiation can occur whenever baryonic charges are accelerated. Formulas are given for branching ratios in scattering at large momentum transfer in proton-antiproton annihilation at high energy. The angular distribution and the energy spectrum of the ω's are also given. It is suggested that experimental determination of these quantities could test the gauge theory and provide measurements of the renormalized coupling constant for the interaction between baryons and ω mesons. (auth)

1371 ON THE ISOVECTOR CHARGE FORM FACTOR OF THE NUCLEON IN THE STATIC MODEL. H. Biritz and H. Pietschmann (Universität, Vienna). p.403-5 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

Starting from an equal time commutation relation for the isospin density, and taking it between physical one-nucleon states, an equation is obtained that may serve for the isovector form factors as a corollary to the unitarity relation for the scattering amplitude. This equation is studied in the static model, where a comparison with a direct calculation of the form factor is possible. The results are encouraging even with a crude approximation of the matrix element. It is hoped that a full use of the electroproduction amplitudes in the relativistic case will lead to reliable information on the isovector form factors. (A.G.W.)

1372 NEUTRON FORM FACTORS FROM PION ELECTROPRODUCTION. Ph. Salin. p.405-7 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

Previously the photoproduction of pions on nucleons was studied with an isobaric model that consisted of adding to the total Born terms three isobaric contributions corresponding to the three first pion-nucleon resonances, plus constant real S-wave. This work was extended to virtual photons and applied to electroproduction of pions through the one-proton exchange graph. The differential cross section of the reaction $e + N \rightarrow e + N + \pi$, when the final pion is not observed, was calculated. It was found that the cross section is rather insensitive to values of F_π between 0 and 1 and that the Dirac neutron form factor exhibits a negative sign. Some experimental procedures of interest are proposed. (A.G.W.)

1373 COMPLEX ANGULAR MOMENTUM IN MANY-CHANNEL PROBLEMS. F. Calogero (Università, Rome and Istituto Nazionale di Fisica Nucleare, Rome), J. M. Charap, and E. J. Squires. p.416-19 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

Some of the complications that arise in the discussion of the complex J-plane when many (two-particle) channels are coupled together are pointed out. The possibility of ruling out fixed poles in the J-plane, the relation of fixed poles to the apparent non-shrinking of the forward π-N diffraction peak, and the decoupling of sense from nonsense are considered. (A.G.W.)

1374 HIGHER ORDER WEAK INTERACTIONS. J. G. Taylor (Churchill Coll., Cambridge, Eng.). p.419-22 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

Higher order weak interaction effect bearing on the question of high-energy behavior and on the problem of intermediate vector mesons are discussed. The two-particle exchange approximation to the field equations for the 4-Fermi interaction $G(\bar{x},x)^2$ is first considered. The theories developed are termed dynamically unsatisfactory. Dynamically satisfactory theories can be obtained for Fermi interactions involving at least three different fields at a point. A table of possible resonances for the channels $(\mu\bar{\nu}_\mu,e\bar{\nu}_e)$, $(\mu\bar{e},\nu\bar{\nu}_e)$, and $(\mu\nu_e,e\nu_\mu)$ is shown. (A.G.W.)

1375 COMPOSITE, ELEMENTARY AND RESONANCE PARTICLES IN STRONG INTERACTIONS. J. G. Taylor (Churchill Coll., Cambridge, Eng.). p.422-6 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

Stable and unstable, elementary and composite particles are defined. A simplified model, the pion exchange model, is used in considering the π-π interaction $\lambda\phi^4$, and the possibilities $\lambda = 0$ or $\lambda \neq 0$. To avoid the difficulties involved in numerical solution of the two pion model, a different model, the resonance model, is used. A possible numerical calculation of the ρ resonance is discussed. (A.G.W.)

1376 SOME THEORETICAL RESULTS ABOUT THE DEUTERON PARAMETERS. M. Lacombe (Laboratoire Joliot-Curie de Physique Nucleaire, Orsay, France). p.429-31 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

The question of whether the theoretical nucleon-nucleon interaction derived from the Mandelstam representation could reproduce the experimental data concerning the deuteron is examined. The following parameters for the deuteron are calculated: the electric quadrupole moment Q, the magnetic moment μ_D, the D state probability P_D, the effective range ρ, and the asymptotic D to S wave ratio. The results are tabulated and compared with experimental values. (A.G.W.)

1377 WEAK INTERACTIONS, PERATIZATION, AND SELECTION RULES. C. Bouchiat, B. d'Espagnat, and J. Prentki (CERN, Geneva). p.437-8 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

In conventional theories of weak interactions selection rules are usually accounted for by keeping only the first term in perturbation treatment of the interaction. Such an explanation fails if it is shown that higher order terms contribute in an appreciable way to the phenomenon, as is the case in the peratization theory of Feinberg and Pais. Let A be some quantum number and let, e.g., the interaction hamiltonian H' obey $|\Delta A| \leq 1$. Iterated N times this gives $|\Delta A| \leq N$. If N goes to infinity one is left with an empty rule. It may happen that although each graph separately does not give $|\Delta A| \leq 1$, except just the first one, still the sum of all the selected graphs of the theory obeys $|\Delta A| \leq 1$ again. It is shown here that in the Feinberg and Pais approach for baryon-lepton interactions with strong interaction effects neglected, this is the case. (auth)

1378 REMARKS ON THE "SPURION"-THEORY OF STRANGE PARTICLES. W. Heisenberg (Max-Planck-Institut für Physik und Astrophysik, Munich). p.445-7 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

In the nonlinear spinor theory of elementary particles the strange particles can be represented by making use of a degenerate groundstate that may attach a spurion to a nucleon or a boson. For the symmetry properties of these spurions there are essentially three different possibilities. A table shows the three possibilities, the symmetry operations under which the spurions should be invariant or covariant, and the spurion operators needed for expressing their properties. The second of the three schemes is discussed and compared with experimental results. (A.G.W.)

1379 DIFFRACTION SCATTERING AND THE FORCES AT SMALL DISTANCES. R. Oehme (Univ. of Chicago and CERN, Geneva). p.447-9 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

Some ideas concerning the relation between forces at small distances and the properties of high-energy diffraction peaks in crossed channels are discussed. Scattering amplitudes are considered within the framework of dispersion theory. The model constructed is mainly for pion-nucleon scattering but can be extended to other reactions, especially to pp and $p\bar{p}$ scattering. Shrinking and non-shrinking diffraction patterns can be obtained depending upon the assumptions made about the short-range forces in the $p\bar{p}$ channel. (A.G.W.)

1380 THEORETICAL PREDICTION OF NEW RESONANCES WITHIN THE YUKAWA PARTICLE CLASSIFICATION ASSOCIATED WITH THE ROTATOR MODEL OF ELEMENTARY PARTICLES. L. de Broglie, F. Halbwacks, P. Hillion, and J. P. Vigier. p.461-4 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

A rotator model of elementary particles recently developed starts from the idea that elementary particles are extended material structures within the frame of Minkowski's space-time. Such an idea leads to the introduction of a new internal isobaric group associated with real physical internal rotational motions inside the particles. From this model tables of predicted boson and baryon resonances are constructed. It is concluded that the present situation in resonance phenomena points more and more toward the idea that these states are quantized excited levels of some deeper structure and that their list is more than likely to develop into a limitless hydrogen-like spectra. Whether one can account for this situation with real internal motions of the type suggested or some different type is still an open question. (A.G.W.)

1381 THE PROTON FORM FACTORS FOR $q^2 < 4$ FERMI^{-2}. B. Dudelzak and P. Lehmann (Ecole Normale Superieure, Orsay, France). p.468-72 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

Absolute cross-section measurements of electron-proton scattering made in the last two years in the 250-Mev station of the linear accelerator at Orsay are summarized. The form factors $F_{ch}(q^2)$ and $F_m(q^2)$ are deduced from the cross-section measurements assuming the Rosenbluth formula. The results are compared with recent results from Stanford. (A.G.W.)

1382 ON THE LIFETIME OF THE NEUTRAL π-MESON. D. A. Evans and J. H. Mulvey (Oxford Univ.). p.477-81 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

A stack of Ilford L4 emulsions was exposed to a stopping K^+ beam at Berkeley. The $K_{\pi 2}$ decay of the K^+, $K_{\pi 2} \rightarrow \pi^+ + \pi^0$, was used to estimate the lifetime of the π^0. A final sample of 58 events was measured, errors were estimated, and the flight distance of the π^0 was calculated. The final

result was a lifetime of about 1.5×10^{-16} sec. This result is in agreement with other experiments. (A.G.W.)

1383 PHOTOPRODUCTION OF π^+ MESONS FROM HYDROGEN NEAR THRESHOLD USING LIQUID HYDROGEN BUBBLE CHAMBER. G. Ascoli, E. L. Goldwasser. U. E. Kruse, J. Simpson, W. P. Swanson. p.485-6 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

The x-ray beam of the University of Illinois betatron was hardened by passage through polyethylene, LiH, lucite, and Al, and electrons were swept out. The beam was then passed through a Be window into a 14-in. liquid hydrogen bubble chamber. A total of 13,000 stopping π^+ events between threshold and 180 Mev incident photon energy was obtained. Results of analysis of 7000 of these events are presented as total cross sections. (A.G.W.)

1384 AN EXPERIMENT ON THE TIME-LIKE ELECTROMAGNETIC STRUCTURE OF THE PROTON. M. Conversi, T. Massam, Th. Muller, and A. Zichichi (CERN, Geneva). p.488-93 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

Preliminary results are reported from an experiment being carried out at CERN on one of the rare annihilation modes of the proton-antiproton system, $\bar{p} + p \rightarrow e^- + e^+$. The apparatus described provided a rejection power for unwanted annihilation processes of 1.4×10^{-7}. In runs analyzed so far, 7 events were found to fulfill all selection criteria. The result is that for a time-like q^2 of 6.8(Bev/c)^2 the process investigated has a cross section ~6 times smaller than that expected for a point-like proton. This result confirms with improved statistical confidence previous findings on the first experimental evidence for a time-like proton structure. In a note added after the conference, it is suggested that this result may have a different significance in view of new information obtained by other investigators. (A.G.W.)

1385 ELECTRON-DEUTERON ELASTIC SCATTERING AT THE WEAK MOMENTS OF TRANSFER. D. Drickey, B. Grossetete, and P. Lehmann (Ecole Normale Superieure, Orsay, France). p.493-5 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963. (In French)

The charge form factor of the neutron was obtained as a function of q^2 between about 0.600 and 2.000 f^{-2} by scattering electrons from a solid target of deuterated polyethylene. The ratio of the deuteron and proton form factors was also determined by electron scattering from a target of liquid deuterium and hydrogen. The results were compared with calculations of the neutron charge form factor based on the electron-neutron interaction. The measurements support a positive value for the neutron charge form factor. The ratio of the neutron and proton magnetic form factors for $q^2 = 1.35$ and 1.96 f^{-2} was also obtained. (D.C.W.)

1386 MEASUREMENT OF THE ELECTRIC AND MAGNETIC FORM FACTORS OF THE PROTON FOR A SQUARE FOUR-MOMENTUM TRANSFER OF 5.43 FERMI^{-2}. B. Dudelzak and P. Lehmann (Ecole Normale Superieure, Orsay, France). p.495-7 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

The absolute effective cross section for electron-proton scattering at $q^2 = 5.43$ f^{-2} was measured at 75, 120, 135, and 145°. The ratio of the experimental cross section to the effective cross section of Mott was expressed in terms of functions of the proton form factors, from which the form factors were evaluated. The variation of the ratio of the magnetic and electric form factors with q^2 was obtained, using previous results for $q^2 = 0.60$, 1.00, 2.00, and 2.98 f^{-2}. (D.C.W.)

1387 PERIPHERAL EFFECTS IN PHOTOPRODUCTION OF CHARGED PIONS IN THE 2-6 Bev RANGE. R. Blumenthal (Harvard Univ., Cambridge, Mass.), W. Faissler, P. Joseph, L. Lanzerotti, F. Pipkin, D. Stairs, J. Ballam, H. DeStaebler, and A. Odian. p.498-505 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

Measurements on the photoproduction of charged mesons were carried out at the Cambridge electron accelerator, which was operated at internal electron energies between 3 and 6 Bev. The pions were generally observed approximately 1 Bev below the corresponding electron energies and at production angles varying between 1° and 11° in the laboratory system. The values of the kinematical parameters were chosen to make some of the data involve low momentum transfer to the target nucleus and thus provide favorable conditions for the observation of peripheral effects. The results are shown as differential cross sections versus angle with the maximum bremsstrahlung energy and the pion momentum as the two parameters. The yields are apparently in qualitative agreement with the Drell one-pion exchange model. (A.G.W.)

1388 LASER RADIATION AND HIGH ENERGY PHYSICS. V. A. Tumanian (Inst. of Physics, Erevan). p.505-6 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

Papers on possible applications of lasers in high-energy particle physics are reviewed. Two papers show that as a result of Compton scattering of laser photons by relativistic electrons, γ quanta will be produced with energy comparable to the electron energy. The energy of the γ quanta is simply connected with the angle between the directions of production and primary electrons, their energy spectrum essentially differs from the bremsstrahlung, and a degree of linear or circular polarization up to 100% may be achieved. Another paper suggests the possibility of the use of laser radiation in measuring the cross section of the scattering of light by light. (A.G.W.)

1389 PHOTOPRODUCTION OF π^0-MESONS IN HYDROGEN FROM QUASI-MONOCHROMATIC AND LINEARLY POLARIZED PHOTONS AT THE FIRST RESONANCE. G. Barbiellini, G. Bologna, J. De Wire, G. Diambrini, G. P. Murtas, and G. Sette (CNEN, Frascati, Italy). p.516-22 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fiscia, 1963.

The coherent bremsstrahlung beam of the Frascati 1-Bev electronsynchrotron obtained by using a diamond single crystal as a radiator was used to study π^0 photoproduction at low energy. The measurements consisted in the determination of the number of neutral pions produced in liquid hydrogen at $\theta^* = 90°$ from photons having polarization both perpendicular and parallel to the emission plane. The nominal energy of the photons was fixed at 325 Mev. Results are shown as a plot of π^0 counting rates against the angle between the electron beam and the crystal axis [110]. (A.G.W.)

1390 MEASUREMENT OF ELECTRON AND π^0 ENERGIES ON HEAVY LIQUID BUBBLE CHAMBER PHOTOGRAPHS IN THE CERN NEUTRINO EXPERIMENT. H. Burmeister, G. von Dardel, and K. Schultze (CERN, Geneva). p.552-4 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

In order to get an idea to what extent the total track length of an electron shower is useful for energy determination, the 500-l heavy liquid bubble chamber filled with Freon was exposed to 600-Mev electrons. Measurement of 82 selected showers gave an average total track length of 131 cm with distribution ~15% wide. A total track length of 128 cm was obtained with a Monte Carlo program written for the IBM 709 simulating electron showers under the conditions of the experiment. The Monte Carlo calculation was then used to calculate showers for different energies in order to find a relation between energy and total track length. Results are shown for 2 and 5 radiation lengths.

Good agreement was also found between the total-track-length method and the Behr and Mittner method. (A.G.A.)

1391 CERN NEUTRINO EXPERIMENT— PRELIMINARY BUBBLE CHAMBER RESULTS. H. H. Bingham, H. Burmeister, D. Cundy, et al. (Cern, Geneva). p.555-70 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

In the present stage of the neutrino experiment the 500-l heavy liquid bubble chamber has been operated in the neutrino beam for about 664,000 pulses of the proton synchrotron. From a fiducial volume of 220 liters, 136 events have been analyzed and provisionally attributed to neutrino interactions. The preliminary analysis gives evidence that the number of elastic events is consistent with early predictions, that the Brookhaven Columbia result that $\nu_\mu \neq \nu_e$ is confirmed, and that the total inelastic cross section rises rapidly with neutrino energy, perhaps as E^2. To the level of uncertainty of a few percent of the neutrino event rate, no evidence was found against lepton conservation, and no evidence was found for a neutral lepton current, neutrino flip or strange neutrinos, or violation of $\Delta S = +\Delta Q$. An upper limit to the magnetic moment of ν_μ of 10^{-7} Bohr magnetons is set by the absence of high-energy recoil protons. At this stage of the analysis there is no significant evidence for the proposed intermediate boson. (auth)

1392 CERN NEUTRINO SPARK CHAMBER EXPERIMENT. G. Bernardini, G. von Dardel, P. Egli, et al. (CERN, Geneva). p.571-84 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

Results obtained so far from analysis of about 3000 events induced in the spark chambers are presented. Distribution of events in space and time was essentially uniform. A plot of the distribution of the time-of-flight of the initiating neutral particles showed a pronounced peak at the channel corresponding to the particles travelling with the velocity of light. The rate of elastic events ($\nu + n \rightarrow p + \mu^-$ and $\bar{\nu} + p \rightarrow n + \mu^+$) was 8.5 per hour as compared to 5 per hour expected from the Lee-Yang cross section. Angular distribution of negative muons is also compared with theoretical predictions. Particles emerging from the production region under neutrino conditions were almost exclusively negative (92 ± 4%). A statistically significant discrepancy was found between the observed and expected number of charged lepton pairs. Muon pairs of nontrivial origin were produced at a rate of about 0.5–1% of all events. The rate of elastic electron production was estimated to be 1.1 ± 0.4%. Pairs of electrons and muons were apparently produced at about the same rate as muon-muon pairs. (A.G.W.)

1393 CERN NEUTRINO EXPERIMENT: CONCLUSIONS. J. S. Bell, J. Loevseth, and M. Veltman (CERN, Geneva). p.584-90 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

Conclusions are extracted from other reports on the CERN neutrino experiment presented at this conference and some theoretical remarks are added. The conclusions of the Brookhaven group regarding the two-neutrino question, neutrino flip, and neutral currents are confirmed and strengthened. The evidence on lepton conservation, the indications on weak form factors, energy dependence of cross sections, and lepton pair production are discussed. (A.G.W.)

1394 ANALYSIS OF 4 Gev/c PROTON-PROTON INTERACTIONS. I. ELASTIC SCATTERING WITH HIGH MOMENTUM TRANSFER. C. Dilworth, A. Fedrighini, V. Pelosi, and L. Tallone (Inst. of Physics and I.N.F.N., Milan). p.591-3 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

The Saclay 81-cm hydrogen bubble chamber was exposed to a beam of protons of 4 Bev/c at the CERN proton synchrotron. Results on the differential cross sections of proton-proton elastic scattering at various values of four-momentum transfer greater than one Bev/c are presented. The data are compared with data from other proton-proton scattering experiments and from antiproton-proton scattering. Proton-proton points lie at values about 7 times as high as those of the corresponding points for antiproton-proton scattering. The decrease in relative cross section with energy appears to be considerably faster in proton-proton than in antiproton-proton scattering at high momentum transfer. (A.G.W.)

1395 ELASTIC SCATTERING OF 12 Gev PROTONS ON ON PROTONS. H. Eggstain and G. Kellner (Inst. for Theoretical Physics, Vienna). p.598-601 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

Water-soaked emulsions were exposed to the scattered-out proton beam of the CERN proton synchrotron. A total of 238 events was selected as elastic scattering events on free protons. The total elastic cross section was found to be 9.5 ± 0.9 mb. Differential cross sections for low momentum transfers (below 1 $(Bev/c)^2$) are tabulated and plotted. (A.G.W.)

1396 MEASUREMENTS OF NUCLEON ISOBAR AND DEUTERON PRODUCTION IN PROTON-PROTON COLLISIONS. G. Cocconi, E. Lillethun, J. P. Scanlon, C. A. Stahlbrandt, C. C. Ting, J. Walters, and A. M. Wetherell (CERN, Geneva). p.608-16 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

Differential cross sections for inelastic proton-proton scattering were measured at a fixed laboratory angle of 60 milliradians for incident proton momenta in the range 3.6 to 11.8 Bev/c. Cross sections for production of the $(^3/_2,^3/_2)$, $(^1/_2,^3/_2)$, and $(^1/_2,^5/_2)$ nucleon isobars are shown as a function of four momentum transfer. The production cross section of the $(^3/_2,^3/_2)$ state decreases much more rapidly with increasing four-momentum transfer than those for the isotopic spin $^1/_2$ state. Differential cross sections for the reaction $p + p \rightarrow \pi^+ + d$ were measured for incident momenta between 3.6 and 8.9 Bev/c. Comparisons are made with other results and with the one-pion exchange model. (A.G.W.)

1397 AN ANALYSIS OF π^- INTERACTIONS AT 6.1 Gev/c IN HEAVY LIQUID BUBBLE CHAMBER. G. Bellini, M. di Corato, F. Duimio, and E. Fiorini (Istituto di Fisica and I.N.F.N., Milan). p.616-20 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

Preliminary results are presented from an analysis of inelastic interactions produced by 6.1 Bev/c π^- in the Ecole Politechnique heavy liquid bubble chamber. The γ rays correlated to the interactions were measured and the parameters of the π^0 mesons or at least their number were obtained from the kinematics of the events. The numbers of neutron-like and proton-like events for various multiplicities of the secondary pions are tabulated. The ratio of proton-like and neutron-like interactions is always between 2 and 3. The angular and momentum distributions for π^+, π^-, and reconstructed π^0 mesons are shown for various multiplicities. It is noted that: (1) there is a tendency to isotropy at high multiplicity that can be attributed to core collisions; (2) at low multiplicity the peak due to forward emission is more pronounced for negative pions; and (3) the π^+ mesons seem to be emitted almost symmetrically in the multiplicity-3 events. The mean transverse momentum decreases slowly with multiplicity. (A.G.W.)

1398 ANALYSIS OF THE (π^-p) AND THE (π^-N) INTERACTIONS AT 6.1 AND 18.1 Gev/c LEADING TO 3 PIONS. G. Bellini (Istituto di Fisica and I.N.F.N., Milan), M. di Corato, E. Fiorini, et al. p.621-7 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

The reaction $\pi^- + N \rightarrow N + \pi^+ + 2\pi^- + (x\pi^0)$ (N could be either a nucleon or a nucleus) was studied in the Ecole Polytechnique heavy liquid bubble chamber containing 86% C_3H_8 and 14% CF_3Br by volume and exposed to 6.1- and 18.1-Bev/c π^- mesons. The 3-pion invariant mass distributions of No (three fast prongs, no visible γ rays) and Po (three fast prongs, one proton, no visible γ rays) events show a rather definite maximum around 1150 Mev for the No events, which is considerably reduced for the Po events. Invariant mass distribution of the pion pairs $\pi^+\pi^-$ and $\pi^-\pi^-$ for No events at both energies are shown. The ρ peak is apparent in the $\pi^+\pi^-$ pairs and not in the $\pi^-\pi^-$. A search for an explanation of the large number of events with small $\pi^+\pi^-$ mass found in the reaction $\pi^- + p \rightarrow n + \pi^+ + \pi^- + x\pi^0$ ($x \neq 0$) is discussed. (A.G.W.)

1399 PRODUCTION CROSS SECTIONS OF PIONS, KAONS AND PROTONS IN PROTON-PROTON COLLISIONS. D. Dekkers (CERN, Geneva), J. A. Geibel,,N. M. King, R. Mermod, G. Weber, T. R. Willitts, E. J. N. Wilson, K. Winter, B. Jordan, and M. Vivargent. p.641-3 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

Data on pion, kaon, and proton production in proton-proton collisions at angles of 0 and 100 milliradians and at incident momentum of 18.8 Bev/c are presented. The shape of the spectra for positive and negative pions is similar at 100 milliradians, but in the forward direction there is a strong difference in shape. The positive to negative production ratio changes drastically from 0 to 100 milliradians. The kaon spectra are similar in shape to the corresponding pion spectra. Proton production in the forward direction increases roughly exponentially with momentum between 4 and 12 Bev/c. Ratios of cross sections at 100 and 0 milliradians for pions and kaons are shown as a function of transverse momentum. (A.G.W.)

1400 ON THE DISTRIBUTION OF PIONS AND KAONS FROM PROTON-NUCLEON COLLISIONS AT 22 Gev. G. Damgard and K. H. Hansen (Universitet, Copenhagen). p.643-51 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

At 9 different angles in the interval $20° \leq \theta \leq 150°$ the pion and kaon flux from a small LiH target bombarded with 21.7-Bev protons was studied by the tracks in emulsion blocks placed around the target. At each investigated angle the energy spectrum of $\pi^{\pm}$ ($K^{\pm}$) was found from observation of stopping densities as a function of range in the emulsion blocks and from measurements of multiple Coulomb scattering and ionization of the tracks in the front edge of the emulsion block. The resulting smoothed spectra are shown. An attempt is made to interpret the spectra in terms of an isobar model in which it is assumed that, at these primary energies, a very large fraction of the pions and kaons are produced via nucleon isobars that decay in one or more steps to nucleon ground states. (A.G.W.)

1401 STUDY OF KAON PRODUCTION BY 10 Gev/c π^- MESONS ON PROTONS. S. Brandt and A. Wroblewski (CERN, Geneva). p.666-71 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

In photographs from an exposure of the Saclay 81-in. hydrogen bubble chamber to a 10-Bev/c π^- beam, events with only one K_1^0 decay observed in the chamber were studied. All events were required to show also the production of a proton. The number of events found (79) with protons $\leq$2 Bev/c was much smaller than expected. The probability that a $K^0K^{\pm}$ is accompanied by a proton with momentum $\leq$2 Bev/c seemed to be about three times smaller than the corresponding probability for a $K_1^0K_1^0$ pair. The previously found mass dependence of the mean transverse momentum was confirmed. There was no strong indication of N^* production in $K\overline{K}$ producing reactions. The K^* production, if any, was more abundant in the $K^0K^{\pm}$ channel than in the $K_1^0K^0$ channel. (A.G.W.)

1402 ON THE INTERPRETATION OF VERY HIGH ENERGY EXPERIMENTAL DATA. O. Czyzewski and A. Krzywicki (CERN, Geneva). p.672-5 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

A simple model for high-energy interactions is examined, which satisfies two established facts: (1) transverse momenta of secondaries are small; and (2) inelasticity is on the average small (of the order of 20 to 30%). Interest is limited to the pionization process and to symmetric jets with not too small multiplicity. Weak correlation between secondaries is assumed. The modification of phase space due to (1) and (2) is discussed. The properties of jets that follow from these assumptions are shown to coincide with the experimental results on the two-center jets as well as on the so-called one fireball jets. (A.G.W.)

1403 SOME ASPECTS OF THE PRODUCTION OF STRANGE PARTICLES IN THE INTERACTIONS OF HIGH ENERGY PIONS WITH PROTONS. S. Brandt, Ch. Peyrou, R. Sosnowski, and A. Wroblewski (CERN, Geneva). p.676-82 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

The 80-cm Saclay hydrogen bubble chamber was used to investigate the production of strange particles by 10-Bev/c π^- on protons. Three features of the production processes are discussed: (1) the behavior of baryons emitted in high-energy pion-proton interactions; (2) the dependence of the average transverse momentum of baryons on their center-of-mass system longitudinal momentum; and (3) the dependence of the total center-of-mass system momentum of secondary particles on their mass. It is suggested that the characteristic features of strange particle production in high-energy pion-proton collisions can be explained by assuming the existence of at least two intermediate states. (A.G.W.)

1404 p-p COULOMB INTERFERENCE AT 1.7 Gev/c. J. D. Dowell, R. J. Homer, Q. H. Khan, W. K. McFarlane, J. S. C. McKee, and A. W. O'Dell (Univ. of Birmingham, Eng.). p.683-6 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

Counter measurements of small angle proton-proton elastic scattering in the angular region 1.25−5° lab were carried out in order to detect the interference between Coulomb and nuclear scattering. Preliminary results show that the interference is small, indicating that the real part of the nuclear scattering amplitude is ~10% of the imaginary part. (auth)

Field Theory and Quantum Mechanics

Refer also to abstract 1247.

1405 (NP-14397) LECTURES ON RELATIVISTIC KINEMATICS AND POLARIZATION. Matscience Report 22. R. Hagedorn. Notes by T. S. Santhanam and K. Ananthanarayanan (Istitute of Mathematical Sciences, Madras). [1964]. 178p. Dep.(mn).

Transforms and invariants, units, four-vectors and invariants, transformation of differential cross section, scattering, phase space considerations, relativistic notation, and particle polarization in electromagnetic fields are discussed. (R.E.U.)

1406 (NP-14399) LECTURES ON PARASTATISTICS. Matscience Report 24. S. Kamefuchi. Notes by K. Raman and T. S. Santhanum (Institute of Mathematical Sciences, Madras). [1963]. 101p. Dep.(mn).

A general formalism for parastatistics is developed from the harmonic oscillator by showing that the Heisenberg equations of motion are consistent with a general set of commutation relations. Generalized quantization of field for parastatistics is discussed, and the derivation of com-

mutation relations is described with cross-over to normal statistics in the limit of infinite order. Symmetry properties of state vectors for fields obeying parastatistics are discussed, and generalization of quantum theory is considered. Restrictions arising in a relativistic field theory are examined, and it is shown that the usual spin-statistics connection has a general analog: tensor fields must be quantized according to parabose statistics, and spinor fields according to parafermi statistics. The restrictions on the hamiltonian for interacting fields from the commutation properties of the field operators are considered. The statistics of known elementary particles are determined from their interactions. (R.E.U.)

1407 (NP-14400) LECTURES ON INTRODUCTION TO QUANTUM STATISTICAL MECHANICS OF DEGENERATE BOSE SYSTEMS. Matscience Report 29. F. Mohling (Institute of Mathematical Sciences, Madras). [1963]. 66p. Dep.(mn).

A series of three lectures was given on the free Bose gas, development of the x-ensemble formulation of quantum statistics, and momentum space ordering and quasiparticles in the self-energy problem. (R.E.U.)

1408 (NP-14403) LECTURES ON ANALYTIC S-MATRIX THEORY. Matscience Report 26. Henry P. Stapp (Institute of Mathematical Sciences, Madras). [1964]. 211p. Dep.(mn).

A series of lectures on S-matrix theory presented in March and April 1964, are presented. Titles include: elements of spinor analysis; basic quantum principles and the S-matrix; relativistic invariance and the decomposition principles; analyticity and physical connection; antiparticles, the substitution rule, and C, P, and T invariances; CPT invariance; intrinsic parity; order of variables; the connection between spin and statistics; maximal analyticity; the pole-factorization theorem; discontinuity equations in perturbation theory and S-matrix theory; and crossing, antiparticles, and the physical sheet. (R.E.U.)

1409 (NP-14404(p.2-22)) ORIGIN OF INTERNAL SYMMETRIES. E. C. G. Sudarshan (Rochester, N. Y. Univ.).

Multiplet structures postulated by internal symmetry are discussed. (R.E.U.)

1410 (NP-14404(p.23-35)) CONSTRUCTION OF THE INVARIANTS OF THE SIMPLE LIE GROUPS. L. O'Raifeartaigh (Dublin Inst. for Advanced Studies).

Invariants of the simple Lie groups are found, and implications in group representations of elementary particles are discussed. (R.E.U.)

1411 (NP-14404(p.36-47)) SOME UNCONVENTIONAL REMARKS ON THE SOLUTIONS OF THE DIRAC EQUATION. Alladi Ramakrishnan (Institute of Mathematical Sciences, Madras).

Some fundamental problems in elementary particle theory that defy solution are re-examined in terms of solutions to the Dirac equation. The meaning of the quantum numbers (strangeness and hypercharge), ambiguities resulting from massless particles, the connection between the nonconservation of parity and strangeness, and the relation between apparently unrelated quantities like Q, I_2, S, and N are discussed. (R.E.U.)

1412 (NP-14404(p.49-58)) CROSSING RELATIONS AND SPIN STATES. M. Jacob ([France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay]).

Crossing symmetries of interacting particles, which have spin, are obtained directly from the helicity amplitudes. (R.E.U.)

1413 (NP-14404(p.59-79)) LARGE-ANGLE ELASTIC SCATTERING AT HIGH ENERGIES. R. Hagedorn (European Organization for Nuclear Research, Geneva).

The Regge-pole analysis of the diffraction region is presented, and its invalidity for large angle scattering is discussed. A statistical model for calculation differential cross sections is described. Some experimental results are discussed in terms of the statistical model. (R.E.U.)

1414 (NP-14404(p.80-101)) THE MULTIPERIPHERAL MODEL FOR HIGH-ENERGY PROCESSES. K. Venkatesan (Institute of Mathematical Sciences, Madras).

The behavior of high-energy cross sections for two-particle processes is considered using the multiperipheral model, which is a generalization at high energies of the peripheral model developed through the strip approximation to the Mandelstam representation. (R.E.U.)

1415 (NP-14404(p.102-12)) EFFECTIVE RANGE APPROXIMATION BASED ON REGGE POLES. B. M. Udgaonkar (Tata Inst. of Fundamental Research, Bombay).

An effective-range approximation based on singularities in the complex angular momentum plane is used to describe low-energy scattering. Regge representation is introduced into the approximation. (R.E.U.)

1416 (NP-14404(p.113-27)) REGGE POLES IN WEAK INTERACTIONS AND IN FORM FACTORS. K. Raman (Institute of Mathematical Sciences, Madras).

Regge poles in weak interactions, asymptotic behavior of scattering amplitudes and subtractions in form factors, and Regge poles in weak and electromagnetic form factors are discussed. (R.E.U.)

1417 (NP-14404(p.128-39)) SOME APPLICATIONS OF SEPARABLE POTENTIALS IN ELEMENTARY PARTICLE. A. N. Mitra (Delhi. Univ.).

Separable potentials that satisfy the requirements of translational and time-reversal invariance in elementary particle physics are discussed. Some formal properties found in separable potentials, such as analyticity properties, double dispersion representation, and Regge behavior of amplitides, and the extension of the concept to the domain of relativistic processes involving elementary particles are discussed. (R.E.U.)

1418 (NP-14404(p.166-87)) ON PERATIZATION METHOD. N. R. Ranganathan (Institute of Mathematical Sciences, Madras).

A survey is presented of weak-interaction theories as developed by Feinberg and Pais. The technique (peratization) for summing a class of ladder graphs that yields a finite sum for leptonic and semi-leptonic processes, which produce divergences in perturbation expansion of the Bethe-Salpeter equation, is described. Weak interactions are described by vector boson (W) mediation. (R.E.U.)

1419 (NP-14404(p.188-201)) MUON CAPTURE BY COMPLEX NUCLEI. V. Devanathan (Madras. Univ.).

The atomic capture of a muon by complex nuclei ($Z > 10$) and subsequent decay in-orbit or capture is discussed in terms of the universal Fermi interaction theory for weak processes. An interaction hamiltonian with strong-interaction currents is used; the coupling constants for pseudoscalar, scalar, tensor, and weak magnetism, brought about by strong-interaction effects in the V-A interaction, are considered. (R.E.U.)

1420 (NP-14404(p.203-30)) THE THEORY OF A GENERAL QUANTUM SYSTEM INTERACTING WITH A LINEAR DISSIPATION SYSTEM. R. Vasudevan (Institute of Mathematical Sciences, Madras).

A formalism developed by Feynman and Vernon is described that used Feynman's space-time formulation of non-relativistic quantum mechanics whereby the behavior of a system of interest, which is coupled to other external quantum systems, may be calculated in terms of its own variables only. The effect of the external system(s) can be included in a class of functionals (influence functionals) of the co-ordinates of the system itself. Linear dissipative systems represent measuring instruments in the formalism. (R.E.U.)

1421 (NP-14404(p.231-44)) RECENT DEVELOPMENTS IN THE STATISTICAL MECHANICS OF PLASMAS. Hugh DeWitt (California. Univ., Livermore. Lawrence Radiation Lab.).

The quantum mechanical many-body problems of the statistical mechanics of plasma are discussed. Perturbation theory techniques are used to analyze the equation

of state, electrons in metals (zero-temperature plasma), plasma oscillations, bremsstrahlung and inverse bremsstrahlung, relaxation, and transport coefficients. (R.E.U.)

1422 (NP-14404(p.245-54)) ELECTRODYNAMICS OF SUPERCONDUCTORS. B. Zumino (New York Univ., New York).

Persistent currents, the Meissner effect, and flux quantization in the phenomenological theories of London and Landau-Geinzburg are discussed. (R.E.U.)

1423 (NP-14404(p.255-70)) INTRODUCTION TO QUANTUM STATISTICS OF DEGENERATE BOSE SYSTEM. Franz Mohling (Colorado. Univ., Boulder).

The quantum statistical theory of degenerate Bose systems is discussed. A microscopic theory of liquid He II (degenerate Bose system with interactions) is developed. (R.E.U.)

1424 (NP-14404(p.271-99)) "TEMPERATURE" CUT-OFF IN QUANTUM FIELD THEORY AND MASS RENORMALIZATION. S. P. Misra (Regional Engineering Coll., Rourkela, India).

A cut-off in quantum field theory caused by assuming "temperatures" high enough to give a Maxwellian distribution is developed. Field equations, completeness of free-particle states, translational invariance, physical intermediate particles, and intermediate states on the mass shell with covariance and without conservation of energy or momentum are used to study electron mass renormalization due to electromagnetic interactions, the $\pi^+ - \pi^0$ mass difference, n-p mass difference, and electron-nucleon scattering with identical "temperature" cut-off for each process. (R.E.U.)

1425 (NP-14404(p.311-33)) ON SOME RECENT MATHEMATICAL DEVELOPMENT IN CASCADE THEORY. S. K. Srinivasan (Indian Inst. of Tech., Madras).

The cascade theory of cosmic ray showers is considered for electromagnetic cascade development. (R.E.U.)

1426 (NP-14405) LECTURES ON BROKEN SYMMETRY AND GOLDSTONE BOSON. Matscience Report 27. E. Yamada (Institute of Mathematical Sciences, Madras). [1964]. 35p. Dep.(mn).

A self-consistent method is used to obtain nonperturbative solutions leading to symmetry breakdown in elementary particle theory. A realistic extension of the massless boson coupled with the conserved current, used to explain the breakdown, to SU_3 or γ_5-invariance is discussed. The Goldstone boson mediates the long-range correlation. (R.E.U.)

1427 (ORNL-TM-958) RADIAL INTEGRALS USING REALISTIC SINGLE-PARTICLE WAVE FUNCTIONS AND THE CODE OVERLAP. L. W. Owen (Oak Ridge National Lab., Tenn.). Sept. 30, 1964. Contract W-7405-eng-26. 5p. Dep.(mn); $1.00(cy), 1(mn) OTS.

A FORTRAN code was written to compute radial integrals of a variety of radial operators using single-particle wave functions that are eigenstates of motion in a Woods-Saxon potential well. The radial operators currently available are r^n, $0 \leq n \leq 5$, and $(d/dx)\,(e^x + 1)^{-1}$, where $x = (r - R_0)/a_0$. Other functional forms may be added easily. (auth)

1428 (RISÖ-82) ELASTIC SCATTERING AS A RELATIVISTIC DOPPLER EFFECT. J. Olsen (Denmark. Atomenergikommissionen. Forsøgsinstitut, Risø). Aug. 1964. 10p. Dep.(mm); Jul. Gjellerup, 87, Sölvgade, Copenhagen K, Denmark.

It is demonstrated how the frequency of a Compton-scattered gamma ray and the velocity of a scattered particle can be calculated by means of the relativistic formula for the Doppler effect, where the Doppler velocity is the velocity of the scatterer after the collision. Similarly it is demonstrated that, as viewed from the scatterer, the incoming energy is equal to the outgoing energy. It is shown that the statement that the total phase is invariant under a scattering process leads to the conservation laws of energy and momentum. (auth)

1429 (UCRL-11541) PART I. APPLICATIONS OF THE VARIATIONAL PRINCIPLE TO STATISTICAL MECHANICS. PART II. SOME PROPERTIES OF He^3 (thesis). Chi-ching Sung (California. Univ., Berkeley. Lawrence Radiation Lab.). July 13, 1964. Contract W-7405-eng-48. 81p. Dep.(mn); $3.00(cy), 2(mn) OTS.

PART I. The variational approaches in statistical mechanics are discussed. The relations among several formalisms and possible simplifications are pointed out. The principle is applied to the equation of state of gas-liquid, the Ising model, and the Boson system above the transition temperature. No essentially new results are obtained, but through these simple examples, it is seen how to use the variational principle to make a thermodynamically consistent approximation and how to obtain the stable solutions. PART II. Some equilibrium properties of ^{3}He are calculated by using thermodynamical Green's function formalism. The T-matrix integral equation is solved by neglecting the statistical factor in the intermediate states and using the effective mass approximation. The effective mass and ground state energy are calculated and the correction due to the statistical factor is estimated. (auth)

1430 (UCRL-11679) A QUANTUM STATISTICAL CALCULATION OF THE PROPERTIES OF LIQUID HELIUM-THREE (thesis). Donald Edward Beck (California. Univ., Berkeley. Lawrence Radiation Lab.). Sept. 17, 1964. Contract W-7405-eng-48. 136p. Dep.(mn); $4.00(cy), 3(mn) OTS.

Many-body Green's functions are employed to develop a thermodynamically consistent microscopic theory of the properties of liquid ^{3}He. A two-body correlation or "T-matrix" approximation, which is appropriate for a system of fermions interacting through strong short range forces, is employed. Separable potentials which are adjusted to represent the interaction of two helium atoms are employed to simplify the coupled integral equations of this approximation. A computer program is used to solve these integral equations at zero temperature. In contrast to other calculations, the single-particle Green's functions have imaginary parts. The thermodynamic properties of liquid ^{3}He are considerably improved over other calculations, and in reasonable agreement with experimental values. (auth)

1431 ON THE MUTUAL FRICTION BETWEEN THE NORMAL AND SUPERFLUID COMPONENTS IN A ROTATING BOSE GAS. S. V. Iordansky (Steclov Mathematical Inst., Moscow). Ann. Phys. (N. Y.), 29: 335-49(Oct. 5, 1964).

The hydrodynamical equations for superfluid in the presence of vortex lines are obtained from microscopic theory. The appropriate mutual friction force is expressed in terms of correlation functions which can be calculated from the solution for a single line. In the case of a weakly interacting bose gas this expression simplifies, and it is possible to connect the friction force with characteristics of the scattering problem for excitations in the field of a vortex line. The final expression contains, besides the transport cross section, some other characteristics of the scattering problem due to the singularity on the vortex line. The additional terms change considerably the magnitude of the friction force. (auth)

1432 MEASUREMENT OF A QUANTUM ENSEMBLE BY A CLASSICAL APPARATUS. Asher Peres and Nathan Rosen (Israel Inst. of Tech., Haifa). Ann. Phys. (N. Y.), 29: 366-77(Oct. 5, 1964).

A simple model of an ensemble of quantum systems interacting with a classical test body is described, the test body serving to measure the expectation value of a dynamical variable of the quantum systems. An expression is derived for the minimum interaction needed to perform the measurement, and it is shown that an interaction which is strong enough to determine an expectation value will transform a pure-state ensemble into a mixture. The model can be generalized to the case in which the expectation values of several variables are measured. Finally, the test body is described by means of quantum mechanics, and its most probable behavior is found to be that corresponding to the previous classical description. (auth)

1433 THE PRINCIPLE OF EQUIVALENCE. A. L. Harvey (Queen's College, New York). Ann. Phys. (N. Y.), 29: 383-90(Oct. 5, 1964).

The principle of equivalence is investigated as a test which a prospective theory of gravitation must satisfy. It is shown that only the strong form of the principle can be considered to be acceptable. The situation is illustrated by application to the first theory of Nordstrom (a special relativistic generalization of Newtonian theory) and the general theory of relativity. (D.C.W.)

1434 THEORY OF TRANSPORT PHENOMENA IN AN ELECTRON-PHONON GAS. T. Holstein (Univ. of Pittsburgh). Ann. Phys. (N. Y.), 29: 410-535(Oct. 5, 1964).

A quantum transport theory is developed for a model electron-phonon gas, as described by the Frohlich hamiltonian. (auth)

1435 SOLUTION OF THE RADIAL SCHROEDINGER EQUATIONS BY VARIATION IN PARTIAL REGION. Klaus Mueller (Technische Hochschule, Brunswick). Ann. Physik (7), 13: 351-76(1964). (In German)

The Schroedinger variation principle for the radial wave equation of a single electron problem can be so modified that the integration in the variation functional to be used extends only over partial regions. This is possible by introduction of supplementary boundary conditions on the integration limits in which the logarithmic derivation of the wave function occurs. The corresponding Ritz method was discussed and calculated as an application of the ground state of an electron in the field of a nuclear charge which is partially shielded by a small spherical surface charge. (tr-auth)

1436 QUANTUM THEORY OF ATOMS AND MOLECULES. Oktay Sinanoglu and D. Fu-Tai Tuan (Yale Univ., New Haven). Ann. Rev. Phys. Chem., 15: 251-80(1964).

Quantum theory studies of molecular geometries, charge distributions, binding energies, inter- and intra-molecular forces, one-electron properties, and spectral levels for small and large molecules are discussed. A general framework is presented that starts from the detailed form of the exact wave function ψ and energy E of a single or several interacting atoms or molecules. Different portions of ψ and E are related to various semiempirical and nonempirical approaches. (M.C.G.)

1437 A POYNTING VECTOR FOR GRAVITATIONAL RADIATION IN GENERAL RELATIVITY. Silvano Bonazzola. Compt. Rend., 259: 1011-14(Aug. 3, 1964). (In French)

It is shown how it is possible, without renouncing a space-curve theory of gravitation, to find a Poynting vector for gravitational radiation that has a zero Riemann covariant divergence. Such a vector is constructed by using as field variables the coefficients of the g_{ik} metric and the Minkowski covariant derivatives $g_{ik,l}$. The supplementary gauge conditions are given for the unequivocal determination of the physical magnitudes that can be obtained by the Poynting vector. (tr-auth)

1438 QUANTUM THEORY OF THE TRANSPORT PROCESS. Janos Hajdu (Université, Paris and Universität, Gottingen, Ger.). Compt. Rend., 259: 1019-21(Aug. 3, 1964). (In French)

A transport equation was established for the case of the presence of an electric field, a magnetic field, and a low temperature gradient. (tr-auth)

1439 ON RUMER'S INVARIANT THEORY OF GRAVITATIONAL WAVES. K. D. Krori (Cotton Coll., Gauhati, India). Indian J. Phys., 38: 190-3(Apr. 1964).

Propagation of gravitational potential and gravitational field-strength was considered on the basis of Rumer's Invariant Theory of Gravitational Waves. Special cases of a weak field were discussed. (auth)

1440 RADIATION OF POINT AND EXTENDED CHARGES MOVING NEAR AN INTERFACE WITH GYROTROPIC DIELECTRIC. E. D. Gazazyan and O. S. Mergelyan (Inst. of Physics, Erevan and Central Research Lab. of Physics and Tech., Academy of Sciences, Armanian SSR). Izv. Akad. Nauk Arm. SSR, Ser. Fiz. Mat. Nauk, 17: No. 4, 95-101(1964). (In Russian)

Radiation from point and extended charges moving in a vacuum along an interface with a dielectric in an external magnetic field was studied. The problem was resolved with a small gyration parameter (q) of the order of 10^{-3} to 10^{-6}. The selected conditions were such that g did not affect either field amplitudes or radiation intensity, but strongly rotated the radiation polarization plane.

1441 DIFFRACTION RADIATION OF A POINT CHARGED PARTICLE. D. M. Sedrakyan (Lebedev Inst. of Physics, Moscow). Izv. Akad. Nauk Arm. SSR, Ser. Fiz. Mat. Nauk, 17: No. 4, 103-8(1964). (In Russian)

Diffraction radiation of a point charge moving at a small angle to a semi-finite metallic screen was studied for the case in which the angle of incidence and the semiplane edge varied from 0 to π. The total radiation at $\beta \rightarrow 1$ is proportional to the energy of the particles and converges to zero at $\vartheta \rightarrow 0$ as $\sin^2 \vartheta$. (R.V.J.)

1442 SOME REMARKS CONCERNING A PATHOLOGICAL MATRIX OF INTEREST IN THE INVERSE-SCATTERING PROBLEM. Peter J. Redmond (Defense Research Corp., Santa Barbara, Calif.). J. Math. Phys. (N. Y.), 5: 1547-54(Nov. 1964).

A Hermitian matrix which occurs in the theory of the quantum-mechanical inverse-scattering problem has apparently contradictory properties. It has a well-behaved inverse in spite of having zero as one of its eigenvalues. The properties of the matrix are investigated and the relevance of the results to the theory is discussed. (auth)

1443 CHARACTERS OF IRREDUCIBLE REPRESENTATIONS OF THE SIMPLE GROUPS. II. APPLICATION TO CLASSICAL GROUPS. J.-P. Antoine and D. Speiser (Université, Louvain, Belg.). J. Math. Phys. (N. Y.), 5: 1560-72(Nov. 1964).

The general formulas found previously for the characters of irreducible representations of simple Lie groups are developed in the case of the classical groups: the four series A_l, B_l, C_l, D_l, plus the exceptional case G_2. Groups of rank 1 and 2, plus $A_3 \simeq D_3$ are studied in detail. (auth)

1444 OBSERVABLES IN RELATIVISTIC QUANTUM MECHANICS. W. C. Davidon (Haverford Coll., Penna.) and H. Ekstein. J. Math. Phys. (N. Y.), 5: 1588-94(Nov. 1964).

The conventional statement of statistical determinism is that "the expectation values of all (Heisenberg) observables are determined by the expectation values of the observables at one time." This requires that a full algebra of self-adjoint operators be in one-to-one correspondence with measurement procedures performed at one time. For instance, it requires that if two noncommuting observables p and q are defined at t = 0, there should exist a measurement procedure at t = 0 corresponding to p + q. No such procedure is known. The contrast between the positive assertion of the existence of certain laboratory procedures and the inability to describe them constitutes perhaps the weakest point of quantum mechanics. However, the conventional statement of statistical causality is shown to be untenable in a relativistic theory. A weaker form of causality is proposed which uses measurements made within a truncated light cone rather than at one time for predictive purposes, and which involves only strictly localized states, i.e., states which are vacuumlike outside a finite volume. Failure of the conventional causality statement implies that the set of quasilocal observables is not necessarily linear, i.e., if A and B are in a set, A + B is not necessarily in it. This remark may open the way to a systematic inquiry into the problems of associating laboratory procedures to self-adjoint operators. (auth)

1445 COULOMB GREEN'S FUNCTION. Julian Schwinger (Harvard Univ., Cambridge, Mass.). J. Math. Phys. (N. Y.), 5: 1606-8(Nov. 1964).

A one-parameter integral representation is given for the momentum space Green's function of the nonrelativistic Coulomb problem. (auth)

1446 DYADIC ANALYSIS OF SPACE-TIME CONGRUENCES. Frank B. Estabrook and Hugo D. Wahlquist (California Inst. of Tech., Pasadena). J. Math. Phys. (N. Y.), 5: 1629-44(Nov. 1964).

A physical 3-vector and dyadic formalism for the treatment of general relativistic problems is derived, by systematic introduction of a proper tetrad field. The method is especially appropriate when there exists a physically or geometrically preferred timelike congruence; all quantities in the formalism are then shown to have immediate physical interpretation as proper local observables. A complete and nonredundant set of equations for the analysis of timelike congruences is developed in this operational language. Application is made to some simple examples involving local observations, and the direct measurement of the Riemann tensor discussed. (auth)

1447 ALGEBRA OF DIRAC BILINEARS. R. Penney (Ford Motor Co., Dearborn, Mich.). J. Math. Phys. (N. Y.), 5: 1657-8(Nov. 1964).

All of the possible quadratic relations among the Dirac bilinear covariants which one may construct using both the usual bispinor and its charge-conjugate are given. Many interesting purely algebraic results are found for a general Dirac field. (auth)

1448 TWO CLASSES OF NEW CONSERVATION LAWS FOR THE ELECTROMAGNETIC FIELD AND FOR OTHER MASSLESS FIELDS. Thomas A. Morgan (Syracuse Univ., N. Y.). J. Math. Phys. (N. Y.), 5: 1659-?(Nov. 1964).

The existence of a class of conserved tensors $T_{\mu\nu\alpha_1}\ldots\alpha_n\beta_1\ldots\beta_m$ and the existence of a class of conserved tensor densities $V_{\mu\nu\alpha_1}\ldots\alpha_n\beta_1\ldots\beta_m$ is exhibited for the electromagnetic field. They are differential generalizations of the energy momentum tensor in the sense that they are bilinear in E and B, contain n + m derivatives and are symmetric, trace free and divergenceless on their $\mu\nu$ pair of indices. Corresponding conserved quantities for the two-component neutrino field, linear gravitational field and indeed for all massless free fields are also exhibited. (auth)

1449 VARIATIONAL APPROACH TO THE MANY BODY PROBLEM. J. Da Providência (Universitet, Copenhagen). Nucl. Phys., 61: 87-96(Jan. 1965).

The properties of a system of many fermions are studied with the help of the variational principle of quantum mechanics. A trial wave function is assumed, which takes into account two-body correlations but neglects higher-order effects. From this assumption it follows in a natural manner that the ground-state energy of the system is essentially given by a simplified version of the Brueckner theory, but the excitation energies are given by the second random phase approximation. The existence of a variational basis for the equations derived may be useful for obtaining approximate solutions in practical cases. (auth)

1450 QUANTISED FIELDS AS RANDOM CLASSICAL FIELDS. R. Bourret (Academia de Ciencias de la Republica de Cuba, Havana). Phys. Letters, 12: 323-5 (Oct. 15, 1964).

A classical statistical process is used to describe the interaction of a classical field with a random field. The process involves finding the ensemble-averaged interaction field by means of integral equations whose kernel functions contain various combinations of the autocorrelation function of the random field. The particular combination used depends on the approximation employed. It is shown that a generalized quantization of the random field, followed by a calculation of vacuum expectation values, is entirely equivalent to the classical statistical procedure employed. (T.F.H.)

1451 CONCERNING SPACE-TIME AND SYMMETRY GROUPS. Meinhard E. Mayer (Brandeis Univ., Waltham, Mass.), Howard J. Schnitzer, E. C. G. Sudarshan, R. Acharya, and M. Y. Han. Phys. Rev., 136: B888-92 (Nov. 9, 1964).

Several theorems are proved that exhibit the impossibility of constructing nontrivial products of the Lorentz group with internal symmetry groups for some physically interesting examples. It is also shown that if the Lorentz group is replaced by the Galilei group, qualitatively different results are obtained, viz a "linear" breakdown of internal symmetry is possible. (auth)

1452 LORENTZ INVARIANT LOCALIZED STATES. T. O. Philips (Carleton Coll., Northfield, Minn.). Phys. Rev., 136: B893-6(Nov. 9, 1964).

Newton and Wigner (Rev. Mod. Phys., 21: 400(1949)) discussed the definition of "localized states" in terms of invariance conditions. However, their localization conditions are not Lorentz-covariant. A modified set of invariance postulates is presented that includes a Lorentz invariance condition. It is shown that for spinless systems there exist states satisfying the modified set of postulates; these states are calculated explicitly. The procedure appears to preclude the existence of Lorentz-covariant "position operators." (auth)

1453 GENERALIZED MASTER EQUATION FOR QUANTUM-MECHANICAL SYSTEMS TO ALL ORDERS IN THE DENSITY. Jerome Weinstock (National Bureau of Standards, Washington, D. C.). Phys. Rev., 136: A879-88 (Nov. 16, 1964).

An exact generalized master equation is derived for a large quantum-mechanical system in the form of a power series in the density. This derivation is a quantum-mechanical generalization of a previous work for classical systems. The quantum equation can be viewed as a time-dependent analog of the virial expansion of the quantum-mechanical partition function—for both degenerate systems (Bose-Einstein or Fermi-Dirac statistics) and nondegenerate systems. The coefficients of the series, in the quantum master equation, are explicitly given in terms of operators (Green functions) which are determined by the dynamics of isolated groups of particles and are convergent functions of the interaction potential. Equations are obtained for the off-diagonal elements of the density matrix as well as for the diagonal elements. The equation for the diagonal elements is shown to reduce to a Markoffian master equation for asymptotically long times, and an explicit expression is obtained for the scattering operator of this asymptotic equation. (auth)

1454 DEGENERATE BOSE SYSTEM. IV. QUASIPARTICLE MODEL. F. Mohling (Univ. of Delhi) and I. Rama Rao. Phys. Rev., 136: A938-53(Nov. 16, 1964).

A quasiparticle model of the Bose fluid is developed which provides a simple understanding of the general first-order predictions of the quantum-statistical theory previously presented. The essence of the model is that there are two kinds of quasiparticles superimposed on a background sea of nonzero-momentum superfluid particles. It is out of this sea that superfluid quasiparticles, or holes, and normal-fluid quasiparticles are created. The normal fluid is composed entirely of quasiparticles. The results are only valid at temperatures such that the fraction ξ of zero-momentum (superfluid) bosons is appreciable, although $\xi \neq 0$ for all temperatures below the transition temperature inasmuch as Bose-Einstein condensation is assumed to be the underlying cause of the super properties of a Bose fluid. At T = 0, only the zero-momentum bosons and the nonzero-momentum superfluid sea exist, there being no quasiparticles in this case. It is suggested that the excitations in helium II measured by existing neutron scattering experiments correspond to the destruction of superfluid quasiparticles, and that the creation of normal-fluid quasiparticles should also be observable. (auth)

1455 NOTE ON THE GENERATING FUNCTION OF TWO-TIME GREEN FUNCTIONS. Takeo Matsubara (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto), 32: 50-64(July 1964).

An approach to the two-time Green function method is proposed. In order to give a systematic way of decoupling the two-time Green functions and to overcome the difficulties often encountered in terminating the hierarchy of Green functions, a generating function is introduced; and its properties are examined in detail for a simple model. It is shown that the generating function provides reasonable results even in the case in which conventional approximation for Green functions does not work. The generating function is constructed for a Fermion system with two-body interaction. (auth)

1456 A FORMULA OF NON-LINEAR RESPONSES. Kensuke Tani (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto), 32: 167-9(July 1964).

A quantum statistical-mechanical expression for the expectation value of a physical quantity in a disturbed system is formulated in a closed form, without using a power series expansion in terms of the strength of the external disturbance. (D.C.W.)

1457 VARIATIONAL PRINCIPLE IN DYNAMICAL S-MATRIX THEORY. [PART] I. Daisuke Itô (Hokkaido Univ., Sapporo). Progr. Theoret. Phys. (Kyoto), 32: 171-2(July 1964).

It is shown that the integral equations for the D and N functions in the N/D formalism of s-matrix theory can be obtained from a variational principle similar to that of Lippmann and Schwinger in ordinary quantum mechanical scattering theory. (D.C.W.)

1458 VARIATIONAL DERIVATION OF SHAW'S APPROXIMATION. Daisuke Itô (Hokkaido Univ., Sapporo). Progr. Theoret. Phys. (Kyoto), 32: 172-3(July 1964).

It is shown that Shaw's approximation to the N/D solution for the scattering amplitude can be derived from the variational principle of the preceding article. A method for improving the approximation is proposed. (D.C.W.)

1459 CONSTRUCTION OF COMBINED SCALAR-GRAVITATIONAL FIELDS FROM PURELY GRAVITATIONAL CASE. Nitaichand De (Jadavpur Univ., Calcutta). Progr. Theoret. Phys. (Kyoto), 32: 177-8(July 1964).

A method for constructing the combined scalar-gravitational field from the purely gravitational field is outlined. (D.C.W.)

1460 DYNAMICS OF QUANTUM STATISTICAL CONDENSATE. DERIVATION OF TWO-FLUID THEORY. Tunemaru Usui (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto), 32: 190-206(Aug. 1964).

The equation of motion of the quantum statistical condensate is derived. Oscillations of small amplitude are analyzed, and it is shown that the equations of motion and of continuity of the superfluid and the kinetic equation of the excitation quanta are the appropriate equations in the cases of slight inhomogeneity. Weak interaction is assumed and its existence is taken into account in such an extent that it causes a modification of the excitation spectrum but not any scattering of the excitation quanta. Systems of Bose particles and of Fermi particles are treated. (auth)

1461 MAXIMUM ANALYTICITY IN ANGULAR MOMENTUM AND ENERGY OF THE BETHE-SALPETER SCATTERING AMPLITUDES. Hirosi Abe (Osaka Univ.), Gaku Konisi, and Takesi Ogimoto. Progr. Theoret. Phys. (Kyoto), 32: 348-64(Aug. 1964).

It is shown that under a certain mass relation the partial wave scattering amplitude in the ladder approximation is regular in the usual cut plane of the total energy squared and in the whole angular momentum plane except at poles. At the negative integers in the angular momentum plane, the amplitude is concluded to be regular. (auth)

1462 SPINOR FIELD IN FINSLER SPACES. Yoshiro Takano (Yokohama National Univ., Japan). Progr. Theoret. Phys. (Kyoto), 32: 365-6(Aug. 1964).

The equations of spinor fields in Finsler spaces are shown to be no more than the generalized Yukawa equations of nonlocal spinor fields. It is also shown that two gauge fields are necessarily introduced in these equations. A special case is considered, which reduces the results for Finsler spaces to the equivalent results for Minkowski spaces. (T.F.H.)

1463 STATISTICAL THEORY OF MANY PARTICLES. D. A. Kirzhnits. Trudy Fiz. Inst., Akad. Nauk SSSR, 16: 3-49(1961). (In Russian)

The statistical theory of many particles was evaluated considering Hartree-Fock equations written in an explicit operational form by introducing a space operator closely related to space levels and distribution functions. The Hartree approximations are used in an investigation of general distribution function properties. Quantum corrections were found for the density and energy for $Z^{-\frac{1}{3}}$ and $Z^{-\frac{2}{3}}$ atoms. Exchange-effect studies showed that mixed exchange-quantum corrections have a relative order $Z^{-\frac{1}{3}} \ln Z$. Exchange and quantum corrections for the Thomas-Fermi relativistic model were found, and the complexity of $1/x^3$ was discussed. Correlation effects for Coulomb systems indicated the importance by system nonhomogeneity. With a small numerical coefficient the relative correlation is of the order of $Z^{-\frac{1}{3}}$. Calculations of total atomic shell energy for isolated neutral atoms reduced the difference between theoretical and experimental values from 62 to 23% (Thomas-Fermi-Dirac method) and 13 to 5% (for Z = 2 to 54). (R.V.J.)

1464 ON THE THEORY OF VAVILOV-CHERENKOV EMISSIONS IN ANISOTROPIC MEDIA AND IN THE PRESENCE OF BOUNDARIES. V. E. Pafomov. Trudy Fiz. Inst., Akad. Nauk SSSR, 16: 94-139(1961). (In Russian)

A short review is given of Vavilov-Cherenkov radiation in various anisotropic media. A hamiltonian method was used in an investigation of Cherenkov radiation peculiarities along the optical axis of a uniaxial dielectric crystal. Emission from electrons moving along a plane interface between two dielectrics, the distribution of the radiation intensity along the Cherenkov cone, and the polarization of emitted waves are discussed. (R.V.J.)

1465 ON THE GEOMETRIZATION OF ELECTRODYNAMICS. K. E. Eriksson (Universitat, Gothenburg, Sweden). p.433-6 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

The following topics are discussed: the connection between the phase of a field operator and the electric charge; the simultaneous appearance of the curvature tensor and the electromagnetic field tensor in the curvature operator; the equations of motion for a field in interaction with the electromagnetic field and the gravitational field; the super selection rule for charge; the equations of motion for the electromagnetic field and the gravitational field; and conservation laws. It is concluded that attempts to geometrize electrodynamic within a four-dimensional classical theory were not successful because the electromagnetic field requires the quantum mechanical concept of phase. (A.G.W.)

1466 ON HIGH ENERGY BOUNDS FOR THE SCATTERING AMPLITUDE. T. Kinoshita, J. J. Loeffel, and A. Martin (CERN, Geneva). p.438-42 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

The elastic scattering of two spin zero particles with equal mass is considered. Two examples are used to examine properties of the scattering amplitude. (A.G.W.)

Geophysics

Refer also to abstract 1698.

1467 (NP-14436) THE TAIL OF THE MAGNETOSPHERE. Research Report 190. W. I. Axford, H. E. Petschek, and G. L. Siscoe (Avco Corp. Avco-Everett Research Lab., Everett, Mass). Aug. 1964. Contract NASw-837. 13p.

Satellite measurements related to the magnetosphere tail are reviewed. The role of tangential stresses in internal convection within the magnetosphere is discussed. Observations of a strong magnetic field in the tail aligned radially from the earth, the existence of a low-energy particle flux in the tail, and the low-energy cosmic cutoff are discussed. (R.E.U.)

1468 ENERGETIC PARTICLES IN THE UPPER ATMOSPHERE. V. I. Krassovskii (Inst. of Physics of the Atmosphere, Moscow). Astronaut. Acta, 10: 60-5 (1964).

Rapidly moving neutral and charged particles in the upper atmosphere whose energy exceeds the thermal energy of the atoms and molecules of the atmosphere are discussed. When these corpuscular streams penetrate to levels of about a hundred km, aurora appear, usually accompanied by disturbances of the ionosphere and the geomagnetic field. Characteristic features of the auroral phenomena are outlined. (C.E.S.)

1469 HIGH ENERGY RADIATION NEAR THE EARTH. S. F. Singer (National Weather Satellite Center, Washington, D. C.). Astronaut. Acta, 10: 66-80(1964).

The intensity of high-energy protons near the earth is considered. The discussion is limited to protons above 80 Mev, that is, both radiation belt protons and solar protons. (C.E.S.)

1470 EQUATORIAL SPREAD-F AND SOLAR ACTIVITY. S. Rangaswamy and K. B. Kapasi (All India Radio, New Delhi). J. Atmospheric and Terrest. Phys., 26: 871-8 (Sept. 1964).

The effect of solar activity on equatorial spread-F was studied using the published tables of f_0F2 from six Afro-Asian stations. The strong negative correlation between equatorial spread-F and magnetic activity observed during sunspot maximum is no longer significant during low sunspot years. On the contrary, a positive correlation between occurrence of equatorial spread-F and magnetic activity is observed in winter of low sunspot years. Similar variations in h'F are also observed with respect to geomagnetic and solar activity. A severe reduction in the width of the belt of equatorial spread-F occurs in low sunspot years. (auth)

1471 GEOMAGNETIC DISTURBANCES ASSOCIATED WITH EQUATORIAL ELECTROJET. B. N. Bhargava and R. V. Subrahmanyan (Astrophysical Observatory, Kodaikanal, [India]). J. Atmospheric and Terrest. Phys., 26: 879-88(Sept. 1964).

Diurnal ranges in the horizontal and vertical force at Kodaikanal, situated about 170 km north of the dip equator in South India, were worked out for quiet and disturbed days at periods of low as well as high solar activity. The maintenance of the range on disturbed days at the same value as on quiet days is discussed. The disturbance diurnal variations (S_D) in H and Z at this station were also computed and are discussed in relation to equatorial electrojet during magnetically disturbed periods. (auth)

1472 DAILY AND SEASONAL CHANGES IN THE EQUATORIAL ELECTROJET IN NIGERIA. P. O. Ogbuehi and A. Onwumechilli (Univ. of Ibadan, [Nigeria]). J. Atmospheric and Terrest. Phys., 26: 889-98(Sept. 1964).

Using data from three magnetic observatories across the magnetic dip equator in Nigeria, a method is devised which yields daily values of jet position, width, and current intensity. Altogether 156 undisturbed days ($Cp \leq 1.2$) were used in the analysis for three different seasons. The three jet characteristics, position, width, and total current are found to vary considerably from day to day. Seasonal changes in the jet were obtained using seasonal mean values of its characteristics. The electrojet was found to move with season towards the summer hemisphere. The movement between December and June is 26 ± 7 km. The jet increases in width during the northern summer, when the sun is over the current layer. No significant change in its total current between seasons is detected. (auth)

1473 IONOSPHERIC EFFECTS OF HIGH-ALTITUDE NUCLEAR EXPLOSIONS. P. R. Sengupta (All India Radio, New Delhi). J. Atmospheric and Terrest. Phys., 26: 919-23(Sept. 1964).

On 9 July 1962, the U.S.A. detonated a nuclear device at a height of 400 km over Johnston Island. Russians detonated two nuclear devices at high altitude in Central Asia on 22 and 28 October 1962. The effect of these three explosions on the ionosphere was studied. The effect on the lower ionosphere is found to be an instantaneous variation in the electron density almost simultaneous with the explosions. This has caused pronounced disturbance in the long-wave field strength received at Delhi of Radio Tashkent on 164 kc. The effect on the upper ionosphere (F2-layer) is seen to be a sharp decrease in the f_0F2 almost simultaneous with the explosion. Thus high altitude nuclear detonations, unlike low altitude ones, are seen to produce nearly simultaneous effect on the ionosphere. Probable causes for the observed effects were discussed. (auth)

1474 THE RARE INSTANCES OF PERIODIC EMISSION OF SYNCHROTRON RADIATION FROM THE AURORAL ELECTRONS. F. T. Berkey and R. Parthasarathy (Univ. of Alaska, College). J. Atmospheric and Terrest. Phys., 26: 936-8(Sept. 1964).

Some of the rare instances when the radio flux from the synchrotron radiation from auroral electrons showed structural details in the radiospectrograph are discussed. An attempt is made to explain the phenomena. It is suggested that the spectrum represents true enhancements in the successive harmonics, about a few hundred megacycles apart, or that the pattern is merely a consequence of periodic dumping. (C.E.S.)

1475 ANOMALOUS DOPPLER RADIATION AND VERY-LOW-FREQUENCY EMISSIONS. G. R. A. Ellis (Univ. of Tasmania, Hobart, Australia). Nature, 203: 1271-2(Sept. 19, 1964).

Many of the short duration electromagnetic emissions from the outer atmosphere show frequency variations. The frequency is observed to fall rapidly with time and then rise usually at a much greater rate, and although the duration and frequency-range may vary within fairly wide limits, the phenomena, called hooks, may be recognized as belonging to a single class. It is generally agreed that hooks are caused by electromagnetic radiation from charged particles traveling through the geomagnetic field. Anomalous Doppler radiation is discussed as the radiation mechanism. (C.E.S.)

1476 IONOSPHERIC BACKSCATTER OBSERVATIONS. J. V. Evans and M. Loewenthal (Massachusetts Inst. of Tech., Lexington). Planetary Space Sci.,12: 915-44(Oct. 1964).

Studies of the electron density and the electron and ion temperatures in the F-region were made by means of ground-based radar observations. A 70-m parabolic antenna directed vertically and a 2.5-Mw pulse radar operating at 440 Mc were employed for these measurements, which were conducted for periods of 30 hours at approximately weekly intervals throughout 1963. Examination of the echo power as a function of height leads to a profile of electron density with height, provided that the electron and ion temperatures are the same ($T_e = T_i$). Additional measurements of the spectra of the signals corresponding to different heights permit the ratio T_e/T_i to be determined, and, where this is different from unity, the observed profile can then be corrected for the effect on the scattering introduced by the inequality in temperature. Results of observations in July 1963 are presented. It was found that the ratio T_e/T_i achieved a maximum value ~2.2 at a height of about 300 km soon after dawn. There was little change in the height dependence in this ratio throughout the daylight hours. At night T_e/T_i was close to unity, but there remained a small difference near 300 km. The ion temperature was found to increase with height at all times, but above 500 km this may be due in part to the presence of an unknown amount of He^+ ions which considerably affects the interpretation of the signal spectra. The electron

temperatures were largely independent of height above about 300 km. (auth)

1477 THE CONNECTION BETWEEN THE RING CURRENT BELT AND THE AURORAL SUBSTORM. Daniel W. Swift (Univ. of Alaska, College). Planetary Space Sci., 12: 945-60(Oct. 1964).

The dynamics of the DR2 radiation belt are studied based on the assumption that the DR2 belt is formed from ionization by collision of energetic neutral hydrogen incident on the earth's upper atmosphere from the direction of the sun. It is shown how this mechanism can lead to an asymmetric development of the DR2 belt, and it is shown that the asymmetric belt is unstable. The growing instability on the nightside of the DR2 belt can account for the quiet time auroral phenomena. The final stages of the growing instability may then result in a partial disruption of the DR2 belt with some of the belt's magnetic energy being released near the midnight meridian. The auroral activation and breakup is then a manifestation of the partial disruption of the DR2 belt, and it is assumed that in this process the DR2 belt returns to a symmetric configuration. The effect of the ionosphere on magnetospheric motions is examined, and it is found that energy dissipation in the ionosphere can account for the expansion of time of auroral forms. It is also shown how rapidly moving magnetospheric plasmas can account for the bright auroral forms during breakup. (auth)

1478 THE MAINTENANCE OF THE NIGHT-TIME F-LAYER. W. B. Hanson and T. N. L. Patterson (Southwest Center for Advanced Studies, Dallas). Planetary Space Sci., 12: 979-97(Oct. 1964).

It is possible in principle that the night-time F-layer is maintained either by H^+ ions in the protonosphere providing a source of O^+ ions through charge exchange, or by an upward drift of ionization which raises the layer to an altitude where recombination is slow. The steady state solution of the H^+ and O^+ ion distributions and fluxes when the H^+ ions act as a source for the F-layer is presented. It is shown that, on the average, the number of H^+ ions that would be consumed by this process cannot be supplied by upward diffusion in the daytime. The alternative hypothesis for maintaining the night-time F-layer by an upward drift of ionization is examined in some detail. The analysis is applied to a particular night-time ionosonde record which is shown to be consistent with a vertical drift velocity of at least 30 m/sec. A method for deducing the drift velocity from h_mF2 and other ionospheric parameters is presented. It is suggested that this information can be used in conjunction with ionization drift velocity data to uniquely determine the ionospheric electric field and the southward component of the atmospheric wind system at F2-peak heights. (auth)

Low Temperature Physics

Refer also to abstracts 571, 1023, 1422, and 1810.

1479 (NASA-TN-D-2156) POTENTIAL ADVANTAGES OF ANISOTROPIC SUPERCONDUCTORS IN "FORCE-FREE" SOLENOIDS. Edmund E. Callaghan (National Aeronautics and Space Administration. Lewis Research Center, Cleveland). Oct. 1964. 10p. $0.50 OTS.

An analysis is made of the use of type II (hard) superconductors in a "force-free" infinite solenoid. Force-free conditions are achieved by a linear variation of helical pitch angle as a function of winding thickness. The force-free condition, that is, current path alined with local magnetic field, also permits the maximum critical current to be carried in the windings, since type II superconductors carry much higher critical currents in parallel, as opposed to transverse, magnetic fields. The overall result showed a considerable increase in axial magnetic field for "force-free" solenoids as compared with the usual (zero pitch) winding techniques. (auth)

1480 (NP-14406) LECTURES ON MAGNETIC PROPERTIES OF A SUPERCONDUCTOR. Matscience Report 28. B. Zumino. Notes by R. Vasudevan and N. R. Ranganathan (Institute of Mathematical Sciences, Madras). [1964]. 66p. Dep.(mn).

A microscopic theory of superconductivity is developed that connects the applied magnetic field and the current in a bulk superconductor. (R.E.U.)

1481 (NYO-2391-2) THEORY OF THE THERMAL CONDUCTIVITY OF SUPERCONDUCTING ALLOYS WITH PARAMAGNETIC IMPURITIES. Report No. 249. Vinay Ambegaokar and Allan Griffin (Cornell Univ., Ithaca, N. Y.). Aug. 25, 1964. Contract AT(30-1)-2391. 74p. Dep.(mn); $3.00(cy), 2(mn) OTS.

The electronic thermal conductivity (K_s) of a weakly coupled, isotropic superconductor doped with a small concentration of paramagnetic impurities is computed. The theory of such superconducting alloys has been given by Abrikosov and Gor'kov, and is based on the assumption that the static magnetic impurities are randomly distributed and that their spins are uncorrelated. Starting from a Kubo formula, K_S is calculated by considering the electron-impurity interaction in the ladder approximation. A considerable simplification of the final expression for K_S is obtained if the exchange scattering time τ_S is much larger than the total scattering time. Numerical calculations were made of the ratio of the thermal conductivity in the superconducting and normal states as a function of the reduced temperature (T/T_c) for different impurity concentrations. Among the results found is that while, as Abrikosov and Gor'kov have shown, the energy gap function $\omega_3(T)$ is quite different from the Gor'kov order parameter $\Delta(T)$ in such alloys, K_S/K_n is still less than unity in the "gapless" region ($\Delta\tau_S<1$). Moreover, the dependence of K_S/K_n on the paramagnetic impurity concentration is quite different for high and low values of T/T_c. (auth)

1482 (NYO-2391-4) PHONON SPECTROSCOPY DOWN TO 0.3°K. Report No. 255. W. D. Seward (Cornell Univ., Ithaca, N. Y.). 1964 . Contract AT(30-1)-2391. 11p. (CONF-651-11) Dep.(mn); $1.00(cy), 1(mn) OTS.

From 9th International Conference on Low Temperature Physics, Columbus, Ohio, Aug.-Sept. 1964.

The measurement of the thermal conductivity for doped and undoped crystals as a function of temperature is discussed, and it is shown that the frequency dependence of the scattering mechanism can be deduced. (R.E.U.)

1483 (NYO-2391-5) POINT DEFECT, OPTIC MODE, AND CRITICAL SCATTERING OF PHONONS AT LOW TEMPERATURES. Report No. 271. A. J. Sievers and R. O. pohl (Cornell Univ., Ithaca, N. Y.). 1964 . Contract AT(30-1)-2391. 12p. (CONF-764-4) Dep.(mn); $1.00(cy), 1(mn) OTS.

From Thermal Conductivity Conference, San Francisco, Oct. 1964.

Three mechanisms for phonon scattering are discussed: (1.) The low-temperature thermal conductivity of potassium chloride doped with iodide and also doped with lithium is compared with some point defect scattering models. (2) The low-temperature thermal conductivity of strontium titanate is observed to vary with applied electric field, and the field dependence is associated with the presence of a low frequency optic mode. (3) Anomalous resistance peaks observed near phase transitions in uranium dioxide and potassium dihydrogen phosphate were identified and interpreted as arising from critical phonon scattering. (auth)

1484 (ORNL-3676(p.40-6)) SUPERCONDUCTIVITY AND LOW-TEMPERATURE PHYSICS. (Oak Ridge National Lab., Tenn.).

MAGNETIZATION STUDIES OF TYPE II SUPERCONDUCTORS. Investigations of the magnetization curves, critical temperatures, and residual resistivities of a series of lead–thallium alloys yield results that confirm deviations from the Ginsburg-Landau-Abrikosov-Gorkov theory of type II superconductors. UPPER CRITICAL FIELDS IN TYPE II SUPERCONDUCTORS. Values of

upper critical fields, H_{c2} and H_{c3}, were obtained from critical current vs external field measurements on Pb–Tl samples in a longitudinal configuration. Resistive transition curves yielded accurate results for the critical fields, which are in agreement with the recent theory of surface nucleation fields predicted by Saint-James and de Gennes. EFFECT OF NEUTRON IRRADIATION ON MAGNETIC PROPERTIES OF Fe–Ni ALLOYS. Abstract of paper to be published in a journal. HELIUM-3 CRYOSTAT FOR THERMAL CONDUCTIVITY MEASUREMENTS. A brief description is given of the design and performance of the ^{3}He cryostat, which has been designed and constructed for thermal conductivity measurements at very low temperatures. (auth)

1485 OSCILLATIONS OF QUANTIZED VORTICES IN ROTATING LIQUID HELIUM II. E. S. Raja Gopal (Oxford Univ.). Ann. Phys. (N. Y.), 29: 350-65(Oct. 5, 1964).

The vortex wave experiments in rotating liquid helium II have been usually analyzed by associating a Magnus force and a vortex tension with the vortices. Simple examples are advanced to show that these concepts are not proper in the hydrodynamics of free vortex motions. The dispersion relation for a vortex in a finite container is first calculated and proved to be incompatible with the ideas of Magnus force and vortex tension. The vibrations of a hollow columnar vortex in a rotating liquid are then derived. The connections to the limiting cases of the inertial oscillations of the rotating liquid and Kelvin's results on the vibrations of an isolated vortex are pointed out. The occasion is also taken to correct a slip in Rosenhead's kinematic analysis of the vibrating vortex. The oscillations of a random array of vortices, with a mean spacing b, are investigated next; and the dominant frequency in the rotating frame is $\Omega = (2 - J)\omega_0 + (4\pi)^{-1}\kappa k^2[\ln(1/ka) + 0.1159]$, where the function J(kb) varies from zero at kb = 0 to unity as $kb \to \infty$. Hall's well-known experiments are consistent with this purely hydrodynamic analysis and give a core radius of ~4 Å, compared with the earlier estimates of ~7-30 Å. The studies of vortex motions in an atomistic framework are also discussed. (auth)

1486 CRYOGENICS, HELIUM THREE. J. G. Daunt and D. O. Edwards (Ohio State Univ., Columbus). Ann. Rev. Phys. Chem., 15: 83-108(1964).

Research on liquid and solid ^{3}He is reviewed. The nature of excitations in liquid ^{3}He as revealed predominantly by specific heat, its magnetic and transport properties, zero sound, the possibility of superfluidity, and the effects of pressure on thermodynamic functions are discussed. For solid ^{3}He, the liquid-solid phase transition, the three different solid phases, the specific heat, and the very low temperature course of the melting curve and its relation to the magnetic properties of the solid are considered. (M.C.G.)

1487 SUPERCONDUCTING MAGNETS. J. E. Kunzler. Endeavour, 23: 115-21(Sept. 1964).

The discovery of superconductors was immediately followed by the suggestion that they might be used for generating intense magnetic fields with a relatively low expenditure of energy. Practical difficulties, particularly the fact that the earliest materials lost their superconducting properties in quite small magnetic fields, resulted in no useful progress then being made. Quite recently, however, the discovery of superconductors having different properties has made feasible superconducting magnets producing a field of as much as 100 kilogauss. (auth)

1488 ULTRASONIC DETERMINATION OF THE SUPERCONDUCTING ENERGY GAP IN In_2Bi. G. A. Saunders and A. W. Lawson (Univ. of California, Riverside). J. Appl. Phys., 35: 3322-4(Nov. 1964).

The attenuation of longitudinal ultrasonic waves in the superconducting and normal states of the Bi–In alloy of composition equivalent to In_2Bi was measured at 60 Mc/sec by the double-ended, pulse-echo technique. The decrease in attenuation below the superconducting critical temperature (5.6 ± 0.1°K) and the temperature dependence of the superconducting energy gap were in reasonable agreement with the predictions of the BCS theory. The limiting energy gap at 0°K, 2Δ (0), was determined to be $(3.4 \pm 0.2)kT_c$. These results confirm Anderson's theory of dirty superconductors. The limiting critical field at 0°K was 870 ± 10 gauss. (auth)

1489 STORING ENERGY IN SUPERCONDUCTORS. Ir P. R. Wiederhold (Magnion Inc., Burlington, Mass.). New Scientist, 23: 500-3(Aug. 27, 1964).

The development of superconducting coils for storing inductive energy is discussed. Several storage circuits are illustrated, and potential applications of this method for storing energy are considered. (C.E.S.)

1490 ANISOTROPY OF THE CRITICAL NUCLEATION FIELDS IN SUPERCONDUCTORS. D. R. Tilley (Mullard Research Labs., Redhill, Surrey, Eng.), G. J. Van Gurp, and C. W. Berghout. Phys. Letters, 12: 305-6(Oct. 15, 1964).

The critical magnetic field (H_{c2}) for superconductivity of Nb single crystals is measured in the three major crystallographic directions, and is found to be somewhat anisotropic. The equations for a type II anisotropic superconductor are then invoked to show that the anisotropy of H_{c2} (the bulk nucleation field) is to be expected theoretically as well as experimentally. (T.F.H.)

1491 UMKLAPP CONTRIBUTION TO BULK ABSORPTION IN SUPERCONDUCTORS. Ernest E. H. Shin (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., 136: A889-92(Nov. 16, 1964).

The second-order umklapp contribution to the bulk absorption of radiation is calculated for superconductors at very low temperatures and is compared with the previously calculated normal phonon contributions. The umklapp absorption spectrum exhibits a sharp peak at the frequency ω_g representing the superconducting energy gap. For Pb, it is not only larger than the normal phonon absorption by many orders of magnitude but is also comparable with the skin absorption. It can also exhibit anisotropy in a single crystal through the polarization factor $(\hat{e} \cdot g)^2$ (where $\hat{e}$ is a unit vector in the direction of polarization of the incident radiation and g = reciprocal lattice vector), which appears in the expression for the umklapp absorption rate. (auth)

1492 STUDY OF THE ATTENUATION OF ULTRASONIC SHEAR WAVES IN SUPERCONDUCTING ALUMINUM. Lewis T. Claiborne, Jr., and Robert W. Morse (Brown Univ., Providence). Phys. Rev., 136: A893-905 (Nov. 16, 1964).

Measurements were made of the ultrasonic shear wave attenuation in superconducting aluminum, using 99.999% pure single crystals with parallel faces in the [100], the [110], and the [111] directions. It was found that the temperature dependence of the attenuation could be separated into two parts: a sharp decrease in attenuation very close to the transition temperature and a residual attenuation having a temperature dependence similar to that for the longitudinal waves. The method of adiabatic demagnetization was used to lower the temperature to 0.3°K, and an extrapolated plot of the residual attenuation in this range could be used to determine an effective BCS energy gap. The fraction of the total attenuation represented by the residual attenuation was found to be strongly temperature-dependent. Application of a magnetic field was found to lower the transition temperature as would be expected. In fact, it was found that the method of ultrasonic attenuation could be used to determine the critical fields accurately near the zero-field value, where permeability measurements are difficult. A theory was developed to explain the behavior of the shear-wave attenuation as a function of temperature. The formulation began with approximations which should be valid in the London region and employed a self-consistent method for determining the dissipative forces on the lattice. Suitable modification extended the theory to cover the entire superconducting temperature range. Using the theoretical results, it is possible to determine the parameters τ and l, the electron relaxation

time and mean free path, for one orientation and frequency and then predict the correct results for other frequencies at the same orientation. One thus obtains the correct frequency dependence for the total electronic attenuation. Some correlation was made between results for different orientations. (auth)

1493 SECOND SOUND IN SQUARE AND CUBICAL CAVITIES. Philip J. Bendt (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., 136: A918-26(Nov. 16, 1964). (LADC-6450)

The response of closed square and cubical cavities to linear standing waves of second sound in helium II was studied. In a square cavity, when the number of half-wavelengths n along one side is even, a linear wave in the x direction couples loosely with the y direction, producing standing waves in both directions at two resonant frequencies, in a narrow doublet. The theory of the coupled waves is analogous to that for coupled LC electric circuits. When n is odd, a linear wave does not couple with the perpendicular directions. However, owing to quadratic terms in the thermohydrodynamic equations, a small-amplitude wave at twice the frequency of the standing wave is generated, and this wave is present along both the x and y axes. A theory of these phenomena is presented, along with frequency, amplitude, phase, and Q measurements. The results are similar in cubical cavities, but the number of available coupled-wave modes is reduced by cancellation of waves, due to the symmetry of the cavity. (auth)

1494 MAGNETIC-FIELD PENETRATION AND BREAKDOWN OF SURFACE SUPERCONDUCTIVITY. [PART] I. Myron Strongin, Donald G. Schweitzer, Arthur Paskin, and Paul P. Craig (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 136: A926-8(Nov. 16, 1964). (BNL-8117)

Low-frequency low-field a-c susceptibility measurements of type II and certain type I superconductors have shown complete diamagnetism, until the transition at some surface upper critical field H_{c3}. Measurements in a swept d-c field which show that at sufficiently large sweep rates the a-c field can be made to penetrate the superconductor, and the real part of the a-c susceptibility will be dM/dH along the magnetization curve, with no observable transition at H_{c3} are described. At intermediate sweep rates, the value of the susceptibility becomes more diamagnetic and a partial transition is observed at H_{c3}. For the slowest sweeps and highest frequencies, essentially the full diamagnetic-susceptibility characteristic of the point-by-point measurements is obtained, along with a transition at H_{c3}. These results are of particular significance since they indicate that an a-c field of small amplitude can be made to penetrate a type II superconductor in the mixed state, and can therefore be used to investigate the bulk properties. Two models which were used to explain the results are briefly discussed. (auth)

1495 MAGNETIC PROPERTIES OF SUPERCONDUCTING FILMS. R. C. Casella and P. B. Miller (International Business Machines Corp., Yorktown Heights, N. Y.). Phys. Rev., 136: A928-37(Nov. 16, 1964).

The general Gor'kov equations are solved for a superconducting film in a parallel magnetic field. The method determines the best pairing in the superconducting state without the need for ad hoc assumptions about pairing such as are used in other theories. The critical field $H_c(T)$ and energy gap $\Delta(H,T)$ are determined for temperatures near the transition temperature at zero field T_c. The energy gap in the quasiparticle excitation spectrum is shown to be approximately equal to the spatial average of the order parameter. For films whose thickness d is less than the coherence length ξ_T the Gor'kov equations are nonlocal and differ from the Ginzburg–Landau (GL) equations. In this range $H_c \propto d^{-\frac{1}{2}}$ is found to be in agreement with experiment. For films with $d > \xi_T$ the solution of the Gor'kov equations are the same as the GL results, as expected, since this is a local regime. It is found that for all d (excepting ultrathin films) and in the temperature range $(1 - T/T_c) \ll 1$ the field dependence of the energy gap is the same as that given by the GL equations, i.e, $\Delta(H)/\Delta(0) = \{1 - (H/H_c)^2\}^{\frac{1}{2}}$. Thus, nonlocal effects do not change the field dependence of the gap. Most of the experimental data are in accord with this equation. However, some recent results for aluminum films show deviations which were interpreted as probably being due to the important role played by energy-level quantization of single-particle states in ultrathin films. The extension of the method to lower temperatures and higher fields is also discussed. (auth)

1496 EFFECT OF STRESS ON THE SUPERCONDUCTING TRANSITION TEMPERATURE OF V_3Si. M. Weger (Univ. of California, San Diego, La Jolla), B. G. Silbernagel, and E. S. Greiner. Phys. Rev. Letters, 13: 521-3(Oct. 26, 1964).

The effects of stresses on the superconducting transition temperature of a V_3Si single crystal are studied. It is found that uniaxial stress along the [111] direction, as well as hydrostatic pressure up to 408 atm, has a negligible effect on the transition temperature. Uniaxial stress along the [100] direction produces a depression in the transition temperature. The temperature depression is a linear function of the applied stress, and is about 0.5°K at 1000 kg/cm². (T.F.H.)

1497 RESPONSE FUNCTIONS, SUPERCONDUCTIVITY AND FERROMAGNETISM IN THE MANY FERMION SYSTEM. H. Stern and R. Brout (Université Libre, Brussels). Physica, 30: 1689-1712(Aug. 1964).

At the phase transition, the anomalies of thermodynamic and static response functions coincide due to the fact that the free energy, expressed in terms of response functions at imaginary frequency including zero, has its pole at zero frequency. Previous work has considered the singularities which arise from the polarization of the medium. A study is made of the divergences arising from the modification of the vertex function. The diamagnetic current is related to the free energy via the Ward Identity so that the specific heat anomaly inevitably gives rise to the Meissner effect. Below the transition the system adjusts to the singularity by going into the BCS condensed state. The similarity between BCS theory and ferromagnetism is shown both through a Weiss field approach and diagrammatically by including special correlations between k and −k. Its importance for an understanding of the broken symmetry problem is discussed. Finally, the parallel behavior of the susceptibility and specific heat of a Bloch ferromagnet is demonstrated. (auth)

1498 MICROWAVE PROPERTIES OF SUPERCONDUCTORS. Jonathan I. Gittleman and Bruce Rosenblum (Radio Corp. of America, Princeton, N. J.). Proc. IEEE (Inst. Elec. Electron. Engrs.), 52: 1138-47(Oct. 1964).

The major features of the interaction of microwaves with superconductors are discussed and interpreted in terms of simple phenomenological models. Three limiting cases are treated: the "Pippard limit" which usually holds when the normal state mean free path is large; the "London limit" for small normal state mean free path; and thin films. The nonlinear properties of superconductors and recent microwave studies of superconducting tunneling phenomena are also considered. (auth)

1499 ANALYSIS AND PERFORMANCE OF SUPERCONDUCTIVE COAXIAL TRANSMISSION LINES. R. J. Allen (Westinghouse Electric Co., Baltimore, Md.) and N. S. Nahman. Proc. IEEE (Inst. Elec. Electron. Engrs.), 52: 1147-54(Oct. 1964).

The mechanisms affecting metallic conduction and dielectric properties are discussed in relation to a low-temperature transmission line to provide a basis for analysis of the characteristic change and the remaining losses at low temperature. Specific attention is given to lines employing Teflon or polyethylene as dielectrics, and operating up to 10 Gc. The construction and measured performance of a number of long superconductive coaxial lines is given in support of the analytical results. (auth)

1500 SUPERCONDUCTIVE TUNNELING. M. D. Fiske and I. Giaever (General Electric Research Lab.,

Schenectady, N. Y.). Proc. IEEE (Inst. Elec. Electron. Engrs.), 52: 1155-63(Oct. 1964).

The tunneling mechanisms through a thin insulating barrier between two metals are briefly reviewed, and some device applications based on these mechanisms are mentioned. Three different cases are described: tunneling between metals both in the normal (nonsuperconductive) state, tunneling between them when one or both are superconductive, and Josephson tunneling through a very thin barrier between superconductors. (auth)

1501 CRITICAL TEMPERATURE OF NIOBIUM AND TANTALUM FILMS. J. R. Rairden and C. A. Neugebauer (General Electric Research Lab., Schenectady, N. Y.). Proc. IEEE (Inst. Elec. Electron. Engrs.), 52: 1234-8 (Oct. 1964).

A method is described for deposition of niobium and tantalum films with bulk critical temperatures by electron beam evaporation in a conventional vacuum at relatively low deposition rates. It is shown that the substrate temperature has a very large effect on the resistance ratio and the critical temperature of the film. (auth)

1502 PAULI PARAMAGNETISM AND SUPERCONDUCTING STATE. [PART] II. Kazumi Maki (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto), 32: 29-36(July 1964).

The effect of the Pauli paramagnetism on a superconducting small specimen is investigated, using the general Gor'kov equation. It is shown that the effect is negligible in a usual specimen but appreciable in an extremely small specimen (thickness $d \sim 10$ Å). The change of the gap in the energy spectrum and the specific heat at lower temperatures are calculated. (auth)

1503 ON THE EFFECT OF THE ROUGHNESS OF WALL SURFACES ON THE CRITICAL VELOCITY OF A SUPERFLUID. Noboru Hokkyo (Hitachi Central Research Lab., Tokyo). Progr. Theoret. Phys. (Kyoto), 32: 174-5 (July 1964).

The effect of the roughness of wall surfaces on the critical velocity is investigated in terms of the finite correlation length of surface irregularities (average distance between adjacent points providing suitable conditions for the initiation of vortex motion). (D.C.W.)

1504 SUPERCONDUCTING PROPERTIES OF THE (Nb, Ta, V)$_3$Sn SYSTEM. G. D. Cody, J. J. Hanak, G. T. McConville, and F. D. Rosi. RCA Rev., 25: 338-41(Sept. 1964).

Research efforts are reported on Nb_3Sn, using metallurgical sintering techniques to prepare the compound and its alloys. Such sintered products can indeed provide reliable data on gross measurements such as the transition temperature, but are inadequate for the more sophisticated magnetization studies. (auth)

1505 HIGH-TEMPERATURE PHASE EQUILIBRIUM AND SUPERCONDUCTIVITY IN THE SYSTEM NIOBIUM–TIN. L. J. Vieland. RCA Rev., 25: 366-78(Sept. 1964).

Some high-temperature aspects of the phase diagram of the Nb–Sn system have been investigated. The solubility of Nb in Sn is low at moderate temperatures, reaching about 5 at. % at 1600°C. The β-tungsten phase becomes increasingly Nb rich at high temperatures, reaching a terminal composition of 81.5 at. % Nb, and melting peritectically at 2130°C. Diffusion in the β-tungsten phase appears to be very slow, and it is found that in compacts sintered much below 1800°C, equilibrium is not reached in short-term anneals. Instead, the composition of the β-tungsten phase is always close to Nb_3Sn, and any Nb present above 75% remains undissolved. In compacts sintered above 1800°C, equilibrium is reached in a reasonable time, and both the lattice constant and superconducting transition temperature are functions of composition. This is in contrast to most previous results on sintered material, but is in agreement with results for vapor-deposited materials. A sharp decrease in T_c is found near 80 at. % Nb, and no evidence of disorder was found in a sample with $T_c \simeq 5.6$°K. (auth)

1506 TRANSITION TEMPERATURE OF NIOBIUM STANNIDE. J. L. Cooper. RCA Rev., 25: 405-13(Sept. 1964).

Transition-temperature measurements have been made by an inductance method on sintered and vapor-deposited samples of niobium stannide. The transitions and transition widths are discussed relative to the chemical and metallurgical state of the samples. The shift in the superconducting transition of vapor-deposited Nb_3Sn for a neutron dosage of 2.7×10^{18} neutrons/cm^2 is given. Finally, the transition shift with applied external field is examined, and values for the upper critical field for Nb_3Sn are given, based on existing theory. (auth)

1507 THE SUPERCONDUCTING PENETRATION DEPTH OF NIOBIUM STANNIDE. G. D. Cody. RCA Rev., 25: 414-32(Sept. 1964).

A review is given of the theory of the superconducting penetration depth, and its relation to the properties of type-II superconductors. Measurements of the penetration depth of Nb_3Sn are discussed in terms of this theory. Finally, a calculation is made of the BCS and mixed-state parameters of Nb_3Sn in terms of an effective-mass model. (auth)

1508 THE SUPERCONDUCTING ENERGY GAP OF NIOBIUM STANNIDE. R. W. Cohen, G. D. Cody, and Y. Goldstein. RCA Rev., 25: 433-52(Sept. 1964).

Measurements of the thermal conductivity of Nb_3Sn in the superconducting and normal states are analyzed in terms of the BCS theory of the superconducting state applied to thermal transport. The data lead to a value of $2\epsilon_0 = 3.56\ kT_c$ for the energy gap at 0°K, in agreement with the BCS theory. The experimental basis for the analysis is discussed and several material parameters of Nb_3Sn are derived. Tunneling measurements of the superconducting density of states of Nb_3Sn are analyzed in terms of two models. The first ignores the role of the surface in the tunneling process and differs from the BCS theory in two basic aspects—a finite density of states in the gap, and a value for ϵ_0 approximately $\frac{1}{3}$ that predicted by BCS. The second model is based on the idea that the surface can dominate tunneling in a short-mean-free-path material, such as Nb_3Sn. With the assumption that the energy gap goes to zero at the Nb_3Sn–insulator interface, an excellent fit is obtained for the tunneling characteristics and their temperature dependence. The model implies that the energy gap in the bulk of the specimen is the same as that obtained from the thermal conductivity data, but it drops by a factor of two within one mean free path of the surface. (auth)

1509 LOWER CRITICAL FIELD OF NIOBIUM STANNIDE. R. Hecht. RCA Rev., 25: 453-65(Sept. 1964).

The lower critical field H_{c1} in Nb_3Sn has been measured by identifying it with the threshold field for flux trapping. It is observed that the trapped moment increases quadratically with increasing field above the threshold. To account for this behavior, a model has been constructed that predicts an average critical current density J_c^* near H_{c1} given by $J_c^* = cH_{c1}/(4\pi\lambda)$. The temperature variation of H_{c1} is observed to be $H_{c1} \approx 200\ [1-(T/T_c)^2]$ gauss, indicating a constant Ginzburg–Landau parameter κ. On combining the observed value of H_{c1} with the measured value of $(\delta H_{c2}/\delta T)_{T=T_c}$, it is found that $\kappa \approx 34$, and that the thermodynamic critical field is about 2600 gauss. The corresponding BCS band gap is unusually low, consistent with values obtained from tunneling and penetration-depth experiments. (auth)

1510 CRITICAL CURRENTS AND LORENTZ-FORCE MODEL IN NIOBIUM STANNIDE. G. D. Cody and G. W. Cullen. RCA Rev., 25: 466-78(Sept. 1964).

A study has been made of the angular and field dependence of the critical current in vapor-deposited Nb_3Sn. The results indicate agreement with the Lorentz-force model of flux creep. The model has been generalized to include the case where the applied field and current are not perpendicular, and to include the presence of a self field. For all samples there is a sharp rise in the critical current density at low

longitudinal fields, which is associated with a transition from an inhomogeneous to homogeneous current distribution. The value of the high-field longitudinal current can be related to the self-field produced by the current. Results indicate that the longitudinal current can be essentially field-independent from 10 to 100 kilogauss. (auth)

1511 MICROWAVE STUDIES OF NIOBIUM STANNIDE. Bruce Rosenblum, Manuel Cardona, and Gaston Fischer. RCA Rev., 25: 491-509(Sept. 1964).

The microwave surface resistance of Nb_3Sn has been studied as a function of temperature from 1.5°K to above the transition temperature and in magnetic fields up to 2×10^4 oersteds. These measurements have been used to determine several properties of the material such as $H_{c2}(T)$. The variation of the surface resistance with magnetic field and temperature is not explained theoretically. We discuss several conceivable absorption mechanisms and point out that one, with which certain features of the mixed state can be explained most readily (e.g., the temperature-independence of the surface resistance at low temperatures), results in a model of the mixed state where the flux tubes have essentially normal cores. A large anisotropy in the surface resistance is observed, depending on the relative orientation of the d-c and microwave magnetic fields. An explanation in terms of a laminar model of the mixed state is given and its extension to flux tubes suggested. A hysteretic effect observed in the surface resistance is believed due to an effective surface barrier for the creation and destruction of flux tubes. Observations on some nonstoichiometric samples of Nb_3Sn are reported. (auth)

1512 SURGE-MAGNETIC-FIELD AND PULSE-CURRENT EFFECTS IN NIOBIUM STANNIDE. William H. Cherry. RCA Rev. 25: 510-32(Sept. 1964).

Equipment is described capable of generating surge magnetic fields up to 250 kilogauss longitudinally and 165 kilogauss transversely with a useful crest duration of 1 millisecond, and capable of generating test current pulses up to 500 amperes with up to 5 milliseconds duration. Critical field and current characteristics of superconducting niobium stannide (Nb_3Sn) were obtained with this equipment and suitable measuring techniques. As compared with d-c methods, the surge methods are very laborious and less exact, but achieve great economies in apparatus. Of greater importance, they disclose the extensive range of electrodynamic transient phenomena that appear in Nb_3Sn superconductors. These phenomena are reported in terms of inductive effects of current, effects of Joule heat generated by current, transient magnetic field effects, and interactions between current and field. Examples are given of the oscilloscope traces through which these effects became evident. (auth)

1513 CRITICAL-STATE PHENOMENA AND FLUX JUMPING IN NIOBIUM STANNIDE. J. P. McEvoy. RCA Rev., 25: 533-41(Sept. 1964).

Tube magnetization has been used to study the critical current density of vapor-deposited Nb_3Sn. The results can be described by a model in which the magnetization is derived from an induced current density, $J_c = \alpha/(B_0 + H)$, where H is the transverse magnetic field. This relation has been verified for a series of single-phase Nb_3Sn films deposited on hollow ceramic tubes. Although large variations in the material constants, α and B_0, have been observed, correlation of these variations with other material properties is uncertain at this time. Discontinuities in the magnetization (flux jumps) resulting from instabilities in the induced currents have been observed. The dependence of flux jumping on magnetic field, rate of change of field, and temperature is qualitatively explained in terms of a flux-creep model. (auth)

1514 MAGNETIC FIELD PENETRATION INTO NIOBIUM–STANNIDE DISCS. K. G. Petzinger and J. J. Hanak. RCA Rev., 25: 542-50(Sept. 1964).

The internal field and current distributions in superconducting Nb_3Sn discs have been measured. Under stable transport current conditions (8-ring discs) both the manner of flux penetration and the field and current distributions are found to be in reasonable accord with theoretical predictions. In disc geometries having both very large and very small film widths (1-, 4-, and 20-ring disc) there arise opposing superconducting currents that diminish field shielding and trapping. The opposing currents are formed by an unsymmetrical penetration of the flux toward the center of a disc. Similar effects may be related to the current degradation in superconducting solenoids. (auth)

1515 ANALYSIS OF DEGRADATION EFFECTS IN SUPERCONDUCTIVE NIOBIUM STANNIDE SOLENOIDS. E. R. Schrader and F. Kolondra. RCA Rev., 25: 582-95 (Sept. 1964).

The testing of superconductive coils wound with vapor-deposited Nb_3Sn ribbon confirms the theory that the low-field instabilities inherent in the superconductor are primarily responsible for "degradation" phenomenon. Both short-sample and coil characteristics are discussed. Various means of minimizing and eliminating the degradation effect are suggested, with special emphasis on the use of magnetic fields for stabilization of the superconductor. These principles are illustrated by a description of a 107-kilogauss, 1-inch-bore all-Nb_3Sn magnet. (auth)

1516 SUPERCONDUCTING ENERGY GAP AND NET ELECTRON DRIFT VELOCITY AS FUNCTIONS OF TEMPERATURE AND COOPER-PAIR DRIFT VELOCITY. R. H. Parmenter and L. J. Berton. RCA Rev., 25: 596-612(Sept. 1964).

A tabulation is given of the superconducting energy gap and the net electron drift velocity as functions of temperature and Cooper-pair drift velocity. Reduced variables are used to make the tables applicable to an arbitrary weak-coupling superconductor. A brief discussion is given of the method of calculating the quantities. Several uses of the tables are pointed out. (auth)

1517 PREPARATION AND SUPERCONDUCTING PROPERTIES OF Nb–Sn WIRE BUNDLES. D. Koch, H. Speidel, G. Otto, and E. Saur (W. C. Heraeus GmbH, Hanau, Ger. and Universität, Giessen, Ger.). Z. Physik, 180: 476-82(1964). (In German)

The preparation of Nb–Sn wire bundles with numerous internal Nb_3Sn diffusion layers was described. The principal characteristics of these synthetic high-field superconductors are the utilization of the entire wire core and the enforced formation of penetrating thin Nb_3Sn filaments. High absolute values of the critical current strength were obtained and superconductivity was also guaranteed in high transverse magnetic fields. The dependence of the critical temperature and transition width of the material on the preparation conditions was investigated. Possibilities for increasing the flexibility of the material were discussed. (tr-auth)

Neutron Physics

Refer also to abstracts 825 and 1617.

1518 (AE-154) INTEGRAL PARAMETERS OF THE THERMAL NEUTRON SCATTERING LAW. S. N. Purohit (Aktiebolaget Atomenergi, Stockholm). Sept. 1964. 49p. Dep.(mn).

Integral parameters of the thermal-neutron scattering law, the thermalization binding parameter (M_2), the Placzek's moments of the generalized frequency spectrum of dynamical modes and the energy transfer moments of the scattering law, are theoretically discussed. A detailed study of the variation of M_2, the thermalization time constant, and the effective temperature of the vibrating atoms with the relative weight between intramolecular vibrations and hindered rotations for H_2O is presented. Theoretical results for different scattering models of H_2O are compared with the measurements of integral experiments. A set of integral parameters for D_2O, using Butler's model, were obtained. Importance of the structure of hindered rotations

of H_2O and D_2O in the study of integral parameters is also discussed. (auth)

1519 (BNL-8433) TIME EIGENVALUES AND DEGENERATE KERNELS IN NEUTRON THERMALIZATION. Charles S. Shapiro (Brookhaven National Lab., Upton, N. Y.). Aug. 1964. Contract AT-30-2-GEN-16. 209p. Dep.(mn); $6.00(cy), 4(mn) OTS.

A theoretical analysis of the pulsed neutron experiment is presented. This analysis leads to the "time eigenvalue problem," which is solved to determine the discrete spectrum of eigenvalues and the associated eigenfunctions of the neutron distribution. The solution is obtained for some physical models by six different methods, four of which involve a new method of replacing the scattering kernel by a synthetic, degenerate kernel that reproduces important properties of the true kernel. The solutions obtained with this degenerate kernel method are compared with that obtained by the well-known polynomial method, for which both energy and velocity polynomials are used. The physical models studied include: (a) the heavy crystal model using both the Debye and the Einstein distributions for the frequency distribution of the normal modes, and for values of the Debye (Einstein) temperature ranging from zero to $[\theta/T\ (\omega_E/T)] = 10.0$; (b) the free-gas model for values of the mass ratio from zero to infinity; and (c) a model for water due to Nelkin. The results indicate that the minimum value of $v\Sigma_s(v)$ significantly affects the structure of the time eigenvalue spectrum and plays a central role in the time evolution of a neutron pulse. The significance of this to the pulsed neutron experiment is discussed along with a comparison of the results with experiments. The merits of the degenerate kernel method are demonstrated as well as the improved convergence obtained by using a velocity formulation as opposed to an energy one. The inadequacy of some popular approximations used in the past is demonstrated. Solutions of the "space eigenvalue problem" for the heavy crystal model are presented. (auth)

1520 (CRRP-1203) A REVIEW OF DIFFUSION PARAMETERS FOR THERMAL NEUTRONS IN LIGHT AND HEAVY WATER WITH AN APPENDIX ON THE THERMAL NEUTRON ABSORPTION IN BORON. R. G. Jarvis (Atomic Energy of Canada Ltd., Chalk River, Ont.). Aug. 1964. 59p. (AECL-2072) Dep.; $1.50(AECL).

The report is concerned with the values of the thermal-neutron diffusion parameters for light water and heavy water. It contains a brief review of the more recent experiments and a comparison of their results with the predictions of simple theories. A consistent set of values is derived for transport cross sections, absorption cross sections, and thermal diffusion areas, and the errors are estimated. The thermal neutron absorption cross sections for boron are discussed in an appendix. 72 references. (auth)

1521 (IA-911) THE ADJOINT TRANSPORT EQUATION. M. Lemanska and S. Yiftah (Israel. Atomic Energy Commission. Soreq Research Establishment, Rehovoth). May 1964. 52p. Dep(mn).

A description of the solution of the adjoint transport equation in spherical geometry using the S_n method is given. The numerical process is outlined, and the SNG-AD code prepared for the Philco 2000 computer in TAC mnemonic language is described. The SNG-AD code is used to obtain the adjoint flux for other problems such as perturbation. The code can also be used for the calculation of critical masses and reactivities. These calculations were made for several assemblies and the results are compared with those given by other codes. (auth)

1522 (IA-936) THE MULTIGROUP ADJOINT DIFFUSION CODE FOR THE PHILCO-2000 COMPUTER. M. Lemanska, G. Szwarchbaum, and S. Yiftah (Israel. Atomic Energy Commission. Soreq Research Establishment, Rehovoth). July 1964. 13p. Dep.(mn).

The multigroup, multiregion adjoint equation is solved for spherical geometry in the stationary case, using the method of "continuous calculation." The adjoint diffusion results are briefly compared with the diffusion results. The DIFAD code is shown. (auth)

1523 (JAERI-1058) THE FACTORIZATION METHOD FOR THE MULTIGROUP INTEGRAL TRANSPORT THEORY IN HETEROGENEOUS SYSTEM. Hiroshi Takahashi (Japan Atomic Energy Research Inst., Tokyo). June 1964. 15p. Dep.(mn).

The factorization method, which has been applied to many-group diffusion equations, is extended to the case of many-group integral transport equations and used in the problem of a thermal neutron spectra in heterogeneous systems. The factorization method gives more accurate results than by the iteration method and is useful when the product of the number of energy groups and of subregions is not very large. Also, when the mass of the moderator atoms is very large and the energy change of the neutron in scattering is small, the factorization method is better than the iteration method. The Fortran II code FACTOR for the IBM 7090 for this factorization method is illustrated, and the execution time of this code is discussed. (auth)

1524 (JINR-P-1797) POLYARIZATSIYA NEITRONOV PROPUSKANIEM CHEREZ POLYARIZOVANNUYU PROTONNUYU MISHEN. (Neutron Polarization by Transmission Through the Polarized Proton Target). P. Dragichesku, V. I. Lushchikov, V. G. Nikolenko, Yu. V. Taran, and F. L. Shapiro (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Neutron Physics). 1964. 9p. Dep.(mn).

The method of neutron polarization by transmission through the polarized proton target was experimentally confirmed. A neutron beam was obtained with a 35% polarization in the thermal region and with a 17% polarization in the energy region of 1 ev to 10 kev. (auth)

1525 (KAPL-2165-3) KARE—A SYSTEM OF DIFFUSION THEORY PROGRAMS FOR THE PHILCO 2000. VOLUME III. ITERATION AND PERTURBATION CALCULATIONS. J. L. Fletcher and R. W. Guillette (Knolls Atomic Power Lab., Schenectady, N. Y.). Sept. 15, 1964. Contract W-31-109-eng-52. 51p. Dep.(mn); $3.00(cy), 1(mn) OTS.

The KARE system consists of three iteration programs, each solving the two-dimensional neutron diffusion equation for one through five groups. The first two programs operate in a rectangular (x,y) coordinate system with diagonal boundaries and interfaces permitted. Of these two, the first program, CORK, is used for problems containing less than 5400 mesh points; the second, ITER, solves problems between 5400 and 20,000 mesh points in size. Both x,y programs allow for a 90 deg periodic boundary condition on the top and right sides (rotational symmetry about the top right corner). CORK may also be used for (r,z) problems, but in this case diagonal boundaries and interfaces are not permitted. The third program, FLEER, provides solutions for triangular geometry with the axes at 120 deg to each other. This program will solve the maximum size KARE problem, i.e., up to 20,000 points, and provides a special 120 deg periodic boundary condition on either two or four sides, or a 180 deg periodic boundary condition on the bottom. Perturbation calculations in the KARE system are performed by the PSP program. Normal and adjoint flux calculations are used to compute reactivity change, $\Delta K/K$, caused by perturbations in cross sections. When cross sectional changes result from a temperature perturbation, the temperature coefficient is calculated in ¢/deg F. PSP calculations are permitted in both x,y and triangular geometry within certain boundary condition limitations. (auth)

1526 (ORNL-3715) PROGRAM STATEST, AN APPLICATION OF THE METHOD OF STATISTICAL ESTIMATION TO THE CALCULATION OF NEUTRON FLUX IN ANISOTROPICALLY SCATTERING MEDIA BY MONTE CARLO. W. E. Kinney (Oak Ridge National Lab., Tenn.). Nov. 1964. Contract W-7405-eng-26. 31p. Dep.; $2.00(cy), 1(mn) OTS.

FORTRAN programs to estimate the neutron flux in as many as 50 energy groups and at up to 10 detector loca-

tions or field points in systems composed of not more than two media were written for the CD-1604A and IBM-7090 computers. Each medium may contain as many as 10 scatterers; the total number of anisotropic scatterers in the system, however, is limited to three in the codes as presented. The programs utilize the method of statistical estimation to analyze neutron collisions generated by the Monte Carlo neutron transport code 05R. A P_8 approximation is used for the expansion in Legendre polynomials of the angular distribution of anisotropically scattered neutrons. FORTRAN listings of both versions of the code are presented, along with listings of two subroutines called by the CD-1604A version. (auth)

1527 (ORNL-TM-974) DERIVATION OF FIRST- AND LAST-FLIGHT ESTIMATORS FOR MONTE CARLO COMPUTATIONS OF SCATTERED PARTICLE FLUXES IN ATTENUATING MEDIA WITH SPHERICAL OR PLANE SYMMETRY. S. K. Penny (Oak Ridge National Lab., Tenn.). Oct. 20, 1964. Contract W-7405-eng-26. 9p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Estimators for the first, last, and in-between flights are derived for use in Monte Carlo computations of scattered particle fluxes in attenuating media with spherical or plane symmetry. The derivation is based upon the integral form of the Boltzmann equation. (auth)

1528 PULSED NEUTRON RESEARCH IN NEUTRON AND REACTOR PHYSICS. G. Robert Keepin (International Atomic Energy Agency, Vienna). At. Energy Rev., 2: No. 2, 75-95(1964).

The capabilities of the pulsed-neutron technique for measuring basic neutron diffusion constants, neutron lifetimes, neutron ages, capture and scattering cross sections, prompt and delayed neutron characteristics, and precise reactivity indexes are described following a brief resume of basic pulsed-neutron theory. A wealth of recent experimental and theoretical results is examined with a view towards the future potential of the pulsed method as an incisive research tool. 79 references. (P.C.H.)

1529 TARGETS OF EFFICIENT NEUTRON GENERATORS. Zbynek Hulek. Cesk. Casopis Fys., 14: 467-79 (1964). (In Czech)

The characteristics are given of some types of neutron generators with a high yield. Cooling of the target, which is the basic problem of increasing the yield of neutrons, is dealt with, as is the technique of the heat transfer calculation of a target in conditions of continuous and pulse operation. A rotating target makes it possible to increase the yield. (auth)

1530 PARTICLE MODERATION: RANDOM FUNCTIONAL APPROACH. Martin A. Leibowitz (Bellcomm Inc., Washington, D. C.). J. Math. Phys. (N. Y.), 5: 1516-26(Nov. 1964).

The slowing down of a particle by a homogeneous isotropic moderator is considered. It is shown that finding the collision density of the particle as a function of space and energy is equivalent to finding the probability distribution of a certain random functional. By means of this random functional, expressions for the spatial moments are obtained without imposing any restrictions on the variations of the scattering kernel or cross section with energy. These moments are then used to obtain the age equation, the derivation differing from others in that no a priori assumptions are made on the collision density itself. Finally, as a special case of the above, the time–energy moments are found. (auth)

1531 SOLUTION OF THE INITIAL-VALUE TRANSPORT PROBLEM FOR MONOENERGETIC NEUTRONS IN SLAB GEOMETRY. Robert L. Bowden and Clayton D. Williams (Virginia Polytechnic Inst., Blacksburg). J. Math. Phys. (N. Y.), 5: 1527-40(Nov. 1964).

The initial-value transport problem of monoenergetic neutrons migrating in a thin slab is solved by applying the normal-mode expansion method of Case to the results of Lehner and Wing. Fredholm integral equations are derived for the expansion coefficients. In addition, exact expressions for the eigenvalues of the problem are derived and the results of calculations are presented. The solution is shown to have properties expected from elementary diffusion theory. (auth)

1532 THE AGE OF FISSION NEUTRONS TO INDIUM RESONANCE ENERGY IN WATER. R. K. Paschall (Atomics International, Canoga Park, Calif.). Nucl. Sci. Eng., 20: 436-44(Dec. 1964).

The age of fission neutrons to indium resonance energy (1.46 ev) was measured in water using a plane fission source of finite diameter and essentially infinite plane detectors. This is equivalent to a measurement using axial detectors with an infinite plane source. Thus, unlike measurements using axial detectors with large plane sources, these results do not require calculated corrections to extrapolate to infinite-source geometry. The remaining corrections are small. The age measured in this experiment was 26.48 ± 0.32 cm at a density of 1.0 g/ml. (auth)

1533 A THERMAL NEUTRON EXTRAPOLATION LENGTH MEASUREMENT. Edward E. Carroll, Jr. and Robert W. Stooksberry (Westinghouse Electric Corp., Pittsburgh). Nucl. Sci. Eng., 20: 455-61(Dec. 1964). (WAPD-T-1628(Rev.))

A measurement of the thermal neutron extrapolation length from a semi-infinite slab of pure water has been made using a mock plane-thermal-neutron source. The result is $\delta = 0.35 \pm 0.03$ cm, in agreement with calculations, which range from about 0.30 to 0.35 cm, but disagreeing with results inferred from pulsed neutron source experiments in small geometries, which range from about 0.40 to 0.50 cm. (auth)

1534 A DOUBLE-ITERATION METHOD FOR DETERMINATION OF DIFFUSION LENGTH. Richard E. Kaiser and William R. Kimel (Kansas State Univ., Manhattan). Nucl. Sci. Eng., 20: 468-75(Dec. 1964).

Several methods are available for the determination of thermal diffusion length. In general, those based on one-group diffusion theory are subject to the assumption of a particular source boundary condition. Errors introduced by the assumption of such boundary conditions usually result in incorrect prediction of the relative harmonic content of the thermal flux at different elevations in the pile. The effect of these errors on diffusion-length determination is to cause inconsistency in the results as additional data points taken close to the source are included. A method is presented whereby the constants in the one-group thermal-flux equation are determined experimentally and used in the determination of diffusion length. This method is then compared with other methods used one-group and age-diffusion theory, with respect to the consistency of results obtained. (auth)

1535 LIMITATIONS IN THE ORTHONORMAL EXPANSION OF NEUTRON SPECTRA WITH ACTIVATION MEASUREMENTS. Raymond Gold (Argonne National Lab., Ill.). Nucl. Sci. Eng., 20: 493-512(Dec. 1964).

Activation measurements are utilized to determine approximate representations of neutron spectra in the form of orthonormal expansions. Two different methods, the Gram-Schmidt and least-squares expansions, are examined. The sensitivity of these methods to experimental error in the neutron cross sections is explored. The least-squares method proves generally superior to the Gram-Schmidt method in this application. The computations imply that more accurate spectral information can be obtained from orthonormal expansions that employ fewer cross sections of high precision as opposed to many cross sections of moderate precision. (auth)

1536 ANISOTROPIC SCATTERING IN THE S_N METHOD. P. F. Zweifel and S. B. Garg (Atomic Power Development Associates, Inc., Detroit). Nucl. Sci. Eng., 20: 513-16(Dec. 1964).

The treatment of linear anisotropic scattering in one-group, one-dimensional S_N problems is studied. We con-

clude, partially on a theoretical basis but primarily from numerical results, that the so-called "transport approximation" by which anisotropic scattering is customarily treated gives inferior results to an approximation that utilizes the diffusion theory relation between neutron current and neutron density, the so-called "S_N-P_1" approximation. (auth)

1537 ON THE EVALUATION OF DOPPLER-BROADENED CROSS-SECTION FUNCTIONS. Alex Reichel (Univ. of Sydney). Nucl. Sci. Eng., 20: 547(Dec. 1964).

Hermite polynomials are used to evaluate Doppler-broadened cross sections, as functions of energy and desired accuracy. The functions are cast in forms convenient for computer application. (T.F.H.)

1538 NEUTRON POLARIZATION BY TRANSMISSION THROUGH A POLARIZED PROTON TARGET. D. Draghicescu, V. I. Lushchikov, V. G. Nikolenko, Yu. V. Taran, and F. L. Shapiro (Joint Inst. for Nuclear Research, Moscow). Phys. Letters, 12: 334-7(Oct. 15, 1964).

Polarization of protons is obtained by use of the solid effect at 1.5°K in a single crystal of $La_2Mg_3(NO_3)_{12} \cdot 24H_2O$, in a magnetic field of 10 kOe. The polarization of neutrons scattered by the protons in these targets is measured and calculated, for incident neutron energies of 0.0045 ev to 10 kev. (T.F.H.)

1539 A NOTE ON SPATIALLY INDEPENDENT PROBLEMS OF NEUTRON THERMALIZATION THEORY. Yasushi Shizuta (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto), 32: 175-7(July 1964).

Neutron thermalization in an infinite homogeneous medium at a uniform temperature is considered. It is shown that the heavy monatomic gas model fulfills a sufficiency condition which ensures the correct asymptotic behavior of the solution of the equation for the neutron velocity distribution as a function of time. (D.C.W.)

1540 CONTRIBUTION OF MOLECULAR ROTATION TO INELASTIC SCATTERING OF NEUTRONS IN A GAS. D. Bally (Univ. of Bucharest). Rev. Roumaine Phys., 9: 507-14(1964). (In French)

A method is proposed for expressing in barn/sterad, mole, and Å, taking into consideration the resolution of the apparatus, the experimental data obtained with a three-axis spectrometer in the study of the inelastic scattering of neutrons in gases. This method was used for experimental data obtained in the study of the scattering of neutrons at 0.0256 ev in methane. The contribution of molecular rotations to the inelastic scattering of the neutrons was observed. (tr-auth)

1541 LECTURES FROM THE SECOND NEUTRON PHYSICS CONFERENCE, BOYNE MOUNTAIN, MICHIGAN, JUNE, 1962. Ann Arbor, Mich., Michigan Memorial-Phoenix Project, 1964. 371p. (MMPP-NPC-1962-1)

Lectures are presented on plasma physics and thermonuclear theory, the fast magnetic compression of plasma, application of singular eigenfunction expansion methods to problems in plasma oscillations, neutron thermalization, the electron-neutron interaction, and mesons and baryons. Separate abstracts are prepared for each paper. (C.E.S.)

For abstracts of individual papers see: 1309, 1310, 1542, 1789, 1790, and 1791.

1542 FOUR LECTURES ON NEUTRON THERMALIZATION. Noel Corngold (Brookhaven National Lab., Upton, N. Y.). p.185-289 of "Lectures from the Second Neutron Physics Conference, Boyne Mountain, Michigan, June 1962." Ann Arbor, Mich., Michigan Memorial-Phoenix Project, 1964.

The classical thermalization experiments and the general mathematical apparatus used in their analysis are discussed. Simple models which indicate those properties of the scattering operator that control the various experimental results are considered. (C.E.S.)

Nuclear Properties and Reactions

Refer also to abstract 1260.

1543 (AEEW-M-445) NEUTRON REACTION DATA ON ALUMINIUM AND OXYGEN FOR THE U.K.A.E.A. NUCLEAR DATA LIBRARY; FEBRUARY 1964. D. C. King (United Kingdom Atomic Energy Authority. Reactor Group. Atomic Energy Establishment, Winfrith, Dorset, England). July 1964. 49p. Dep.; $1.40(BIS), 7s.(HMSO).

Data files for aluminium and oxygen prepared during July 1963 to February 1964 for the UKAEA Nuclear Data Library are described. Data from recent compilations were used in the preparation of these new data files that cover the energy range from 15 Mev to 0.0006 ev for aluminium and 0.0001 ev for oxygen. (auth)

1544 (AERE-R-4732) A COMPILATION OF THE SCATTERING LAW FOR GRAPHITE, BERYLLIUM AND BERYLLIUM OXIDE AT 22°C. B. C. Haywood and R. N. Sinclair (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Sept. 1964. 12p. Dep.; $0.50 (BIS), 2s. 6d.(HMSO).

The scattering law for graphite, Be, and BeO at 22°C is presented in the form of listings of the experimental data. A consideration of the possible absolute and relative errors is also given, and estimates of the best lines through the experimental points are listed for guidance. (auth)

1545 (BNL-8417) A NEW LIMIT FOR NEUTRINO-LESS DOUBLE BETA DECAY. E. der Mateosian and M. Goldhaber (Brookhaven National Lab., Upton, N. Y.). [1967]. Contract AT-30-2-GEN-16. 9p. (CONF-550-88). Dep.(mn); $1.00(cy), 1(mn) OTS.

From the International Conference on High-Energy Physics, Dubna, USSR, Aug. 1964.

Attempts to detect double beta decay in ^{48}Ca are described. The role of lepton conservation is discussed. (R.E.U.)

1546 (CEA-R-2485) MESURE DES SECTIONS EFFICACES THERMIQUES D'ABSORPTION DE L'Al, DU Mg, DU Fe ET DU Cu PAR LA METHODE D'OSCILLATION. (Measurements of Thermal Absorption Cross Sections of Al, Mg, Fe, and Cu by the Oscillation Method). Jean-Claude Carre and Rene Vidal (France. Commissariat a l'Énergie Atomique. Centre d'Etudes Nucléaires, Saclay). 1964. 20p. Dep.(mn).

The phase oscillation technique used at ZOE has the property of reducing by a marked factor the effect of neutron scattering by the sample. The absorption cross sections of poorly absorbing and highly scattering materials were measured; for neutrons of 2200 m/s, the following values are obtained: 229 ± 3 mb for Al; 64.2 ± 1.5 mb for Mg; 2.53 ± 0.03 b for Fe; and 3.74 ± 0.04 b for Cu. (auth)

1547 (CEA-R-2486) MESURE DES INTEGRALES DE RESONANCE D'ABSORPTION. (Measurement of Resonance Absorption Integrals). Rene Vidal (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Fontenay-aux-Roses). July 1964. 55p. Dep.(mn).

The measurements were carried out in MINERVE by the pile oscillator technique, without cadmium filter, in a spectrum rich in epithermal neutrons. The values are extrapolated to infinite dilution and corrected for the junction function. For the excess on the part in 1/v, the following values were found: In: 3200 ± 70; Hf: 2080 ± 50; Ag: 670 ± 20; Co: 50 ± 5; Cs: 450 ± 15; and Th: 87 ± 4 barn. (auth)

1548 (HW-81746(p.2.40-1)) THE SPECIFIC POWER AND THE HALF-LIFE OF Pm^{147}. D. M. Fleming (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

The specific power of ^{147}Pm was found to be 0.330 ± 0.0007 w/g. A preliminary value for its half life is 2.68 yr. (auth)

1549 (JINR-D-1799) NUCLEAR FISSION. Summary Report Presented at the Paris Conference on Nuclear

Physics Dedicated to the 30th Anniversary of the Discovery of Artificial Radioactivity. Part II. G. N. Flerov and S. M. Polikanov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Reactions). 1964. 11p. Dep.(mn).

The latest theoretical and experimental investigations on nuclear fission are summarized. The present state of the spontaneously fissioning isomer investigation is discussed. Positive results of recent experiments in Dubna on the production of element 104 are reported. (auth)

1550 (JINR-P-1716) ISSLEDOVANIE α-SPEKTRA IZOTOPOV Dy. (Investigation of the α-Spectrum of Dy Isotopes). I. Makhunka and T. Fenesh (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Problems). 1964. 12p. Dep.(mn).

The α spectra of Dy isotopes produced by spallation of Ta with 660-Mev protons were studied. The measurements were made by means of a semiconductor spectrometer. Results are presented for ^{151}Dy, ^{152}Dy, and ^{153}Dy. Alpha partial half lives were calculated from the measured intensities of α-lines with the aid of the relative yields and α-branching ratio of ^{153}Dy ($3.0 \pm 0.3 \times 10^{-5}$). In the 3.10 to 3.37 Mev energy interval, thorough investigations were carried out to find a possible fine-structure α-line of ^{153}Dy. If such a line exists, its intensity in the interval is less than 0.25% of the intensity of the main ^{153}Dy α-line. (auth)

1551 (JINR-P-1725) POLNYE SECHENIYA VZAIMODEISTVIYA NEITRONOV S PROTONAMI I NEITRONAMI V INTERVALE ENERGII OT 2.6 DO 8.3 Gev. (Total Cross Sections for Neutron Interaction With Protons and Neutrons in the Energy Range From 2.6 Up to 8.3 Gev). B. S. Pantuev, M. N. Khachaturyan, and I. V. Chuvilo (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of High Energy). 1964. 24p. Dep.(mn).

The total interaction cross sections for neutrons with the mean effective energy of 2.6, 3.9, 5.5, 6.9, and 8.3 Bev with protons and neutrons were measured in good geometry ($\theta = 0.228°$). The (n,p) and (n,n) total cross sections are given. (auth)

1552 (JINR-P-1728) NEKOTORYE METODY VYCHISLENIYA PARAMETROV POTENTSIAL'NOGO RASSEYANIYA. (Some Methods of Calculating the Potential Scattering Parameters). V. V. Babikov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Reactions). 1964. 32p. Dep.(mn).

The method of phase functions is generalized to some important cases. A regularization of equations is made for the parametric functions of the low-energy scattering in the presence of bound states. Convenient equations were obtained for the exact account of the Coulomb potential in nuclear scattering, including the effective-range theory. The effect of the tensor forces was also considered in detail. The equations were obtained for calculating the phases and the admixing parameter in different representations. (auth)

1553 (JINR-P-1743) ANALITICHESKII VARIANT KVAZIKLASSICHESKOI TEORII UGLOVOGO RASPREDELENIYA PRODUKTOV REAKTSII ODNONUKLONNOI PEREDACHI. (An Analytic Variant of the Quasiclassical Theory of the Angular Distribution of the One-Nucleon Transfer Reaction Products). Ya. Grabovskii and B. N. Kalinkin (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1964. 11p. Dep.(mn).

The analytic variant of the quasiclassical theory is used to investigate the angular distribution of the transfer reaction products throughout the angular interval for reactions of complex nuclei. (auth)

1554 (JINR-P-1745) SECHENIE REAKTSII DLYA PROTESESSA STOLKNOVENIYA SLOZHNYKH YADER. (The Reaction Cross Section for Complex Nuclear Collisions). B. N. Kalinkin (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1964. 14p. Dep.(mn).

The information obtained from the quasi-classical analysis of experiments on elastic scattering of the complex nuclei was used to calculate the reaction cross section. (auth)

1555 (MIT-905-19) DECAY OF 37-min Sb^{130}. C. E. Bemis, Jr., and G. E. Gordon (Massachusetts Inst. of Tech., Cambridge). Oct. 15, 1964. Contract AT(30-1)-905. 9p. (CONF-758-1). Dep.(mn); $1.00(cy), 1(mn) OTS.

For presentation at American Physical Society Meeting, New York, Jan. 1965.

Gamma radiation from the 37-min isomer of ^{130}Sb was studied using lithium-drifted germanium detectors as well as NaI(Tl) detectors. Coincidence relations were observed using the techniques of gamma-gamma and sum-coincidence spectroscopy with NaI(Tl) detectors. Beta-gamma coincidence relations were also studied. Samples of this species were chemically separated from the gross fission products using appropriate decay times to minimize contributions from other antimony species. The strong coincidence relations for 37-min ^{130}Sb enabled the radiations from this species to be distinguished from those of the parent-daughter pair, ^{131}Sb–^{131}Te, also present in the samples. Gamma rays with the following energies (and relative intensities) were observed: 186(46), 326(46), 808(46), 830(46), 849(100), 1040(15), 1470(16), and 2149(23) kev. The proposed partial decay scheme involves excited levels in ^{130}Te at 849, 1657, 1843, 1889, 2169, 2319, and 3000 kev. The level at 3000 kev is the origin of a five member cascade involving gamma rays of 186, 326, 808, 830, and 849 kev. (auth)

1556 (MIT-2098-74) INELASTIC ELECTRON SCATTERING CROSS SECTIONS FOR ODD-PARITY EXCITATIONS OF Ca^{40}. H. P. Jolly (Massachusetts Inst. of Tech., Cambridge. Lab. for Nuclear Science). [1964]. Contract AT(30-1)-2098. 64p. Dep.(mn); $3.00(cy), 2(mn) OTS.

Cross sections for excitation of the odd-parity states of ^{40}Ca are calculated in the shell model, using the results of a detailed configuration-mixing calculation. Both longitudinal and transverse electric contributions are included. The resulting form factors are compared with the predictions of the surface interaction model and with experimental form factors. (auth)

1557 (NP-14297) MECANISME DES REACTIONS NUCLEAIRES PRODUITES PAR LES NEUTRONS DE 14 Mev SUR DES NOYAUX LEGERS (THESES). (Mechanism of Nuclear Reactions Produced by 14-Mev Neutrons on Light Nuclei (thesis)). Cao Xuan Chuan (Bordeaux. Universite). 1962. 138p. Dep.(mn).

Nuclear reactions produced by 14-Mev neutrons on light nuclei were studied using nuclear emulsions. Nuclear reactions with emission of 2 bodies of the type A(n,α)B were investigated first. The experimental conditions and the techniques used for the utilization of nuclear emulsions were described. The methods followed in the identification of the reaction ^{12}C(n,α)^{9}Be and theoretical considerations on the reaction are reported. The reactions ^{14}N(n,α)^{11}B and ^{16}O(n,α)^{13}C were investigated. Reactions with the emission of three bodies using ^{9}Be(n,2n)^{8}Be* as an example were examined. The two α particles from the decay of ^{8}Be were observed in the emulsions. The excited levels of ^{9}Be and the mechanisms for its formation were investigated. In the three-body problem, the energy spectra of the emitted particles and the angular correlations between the emitted particles were studied. The results obtained were applied to the study of ^{9}Be(n,2n)^{8}Be and D(n,2n)p. (J.S.R.)

1558 (NP-14404(p.140-59)) IMPULSE APPROXIMATION THEORY OF THE PHOTO-PRODUCTION PHENOMENA IN NUCLEI. G. Ramachandran (Institute of Mathematical Sciences, Madras).

The photoproduction of charged and neutral pions on nuclei is treated theoretically using an impulse approximation technique. Cross sections corresponding to definite final states are considered. (R.E.U.)

1559 (NP-14404(p.160-4)) FORM FACTORS OF THE THREE-NUCLEON SYSTEMS H^3 AND He^3. T. K. Radha (Institute of Mathematical Sciences, Madras).

Theoretical results from studies of form factors (charge and moment) for the 3-nucleon systems ^3He and ^3H are summarized. Odd-nucleon binding to the like ones is considered. (R.E.U.)

1560 (NP-14417) RELACIONES ENTRE LAS SECCIONES EFICACES PARA EL PAR ISOMERICO Ba^{133m}, Ba^{133}, PRODUCIDO POR REACCION (d,2n). Informe No. 120. (Relation Between Effective Cross Sections for the Isomers ^{133m}Ba, ^{133}Ba, Produced in the Reaction (d,2n). Report No. 120). S. J. Nassiff, A. Mocoroa, M. Caracoche, and H. Vignau (Argentina. Comision Nacional de Energia Atomica, Buenos Aires and La Plata. Universidad Nacional). 1964. 8p. Dep.(mn).

The relation between effective cross sections (σ_m/σ_g) for the production of ^{133m}Ba and ^{133}Ba in reactions (d,2n) with ^{133}Cs was studied as a function of deuteron energy (10 to 30 Mev). (R.E.U.)

1561 (NP-14430) EXPERIMENTS ON NUCLEAR LEVELS IN ^{35}Cl (thesis). Nicholaas Hazewindus (Delft, Netherlands. Technische Hogeschool). [1964]. 106p. Dep.(mn).

Experiments are described on nuclear levels in ^{35}Cl. Excited states were formed by proton bombardment of ^{34}S; their properties were studied by observing emitted gamma rays or elastically scattered protons. The interest of this investigation for the study of nuclear properties in the 2s-1d shell is outlined, and results are summarized and compared with the predictions of some nuclear models. (auth)

1562 (ORNL-3679(p.1-18)) NUCLEAR CHEMISTRY. (Oak Ridge National Lab., Tenn.).

A rare-earth isotope with a half-life of 13.5 min was discovered and identified as ^{134}Pr. The ^{134}Ce energy levels populated by the decay of ^{134}Pr were consistent with those expected for a 58-proton–78-neutron nucleus on the basis of the energy level systematics for even-even nuclei. The energies (and relative intensities) of the two intense gamma rays from 38-min ^{38}Cl were measured as 1598 ± 5 kev (0.85 ± 0.03) and 2166 ± 5 kev (1.00). The intensity of the 3760-kev cross-over transition in ^{38}Ar was found to be $(4.9 \pm 0.7) \times 10^{-4}$ relative to that of the 2166-kev gamma ray. The decay properties of 2.91-min ^{90}Rb were investigated by scintillation techniques. From single-crystal and gamma-gamma coincidence measurements, 23 gamma-ray transitions can be attributed to the depopulation of 11 excited states in ^{90}Sr. Some properties of even-even nuclei in the medium-weight region were surveyed. Distinct subshell effects were seen in the trends of such states as the first 2+ vibrational level. A three-crystal scintillation pair spectrometer was used to determine the following energies in Mev (and relative intensities) of gamma rays emitted in the decay of 8.8-min ^{43}Ca: 2.22 ± 0.02 (0.40 ± 0.08), 2.36 ± 0.02 (0.57 ± 0.11), 3.10 ± 0.02 (100), 4.085 ± 0.025 (8.7 ± 0.6), and 4.74 ± 0.03 (0.34 ± 0.05). Each of these gamma rays depopulates a level in ^{43}Sc excited through beta decay from ^{43}Ca. Osmium-194 was observed to decay via a 52-kev beta ray to a level in ^{194}Ir at 43.0 ± 0.4 kev. The half-life of this nuclide was measured as 6.0 ± 0.2 yr. The thermal-neutron activation cross section and resonance integral of stable ^{106}Pd, $\sigma_{th} = 0.29$ barn and $I_0 = 5.7$ barns, were obtained with an error of ±10%. A more precise determination than previously reported yielded for ^{104}Ru values of $\sigma_0 = 0.47$, $\sigma_{th} = 0.48$, and $I_0 = 4.6$ barns. A thermal-neutron capture cross section of ^{103}Rh of $\sim 2 \times 10^4$ and a resonance integral of $\cong 1.65 \times 10^5$ barns are reported. Irradiations of the calutron-enriched isotopes ^{98}Ru, ^{99}Ru, ^{100}Ru, and ^{101}Ru and subsequent mass analysis by means of the two-stage mass spectrometer yielded cross-section estimates for these nuclides. By measuring the amount of ^{243}Pu formed in irradiations of ^{242}Pu, a thermal-neutron capture cross section of 25 ± 4 and a resonance integral of 1280 ± 60 barns were determined for ^{242}Pu. Very pure submicrogram samples of ^{232}U produced from ^{231}Pa were irradiated and mass spectrographically analyzed. A thermal (or subcadmium) neutron cross section of 78 ± 4 and a resonance integral of 280 ± 15 barns were measured for ^{232}U. By determining the amount of 21-min ^{107}Rh produced in irradiations of the 1.0-year ^{106}Ru a thermal-neutron capture cross section of 0.35 and a resonance integral of 1.1 barns were found for ^{106}Ru. These values are sufficiently low to signify a negligible neutron loss through poisoning in a nuclear reactor. A measurement was made of the thermal-neutron capture cross section and resonance integral of the 9.0-hr isomer of ^{58}Co. The alpha-to-beta emission branching ratio for ^{249}Bk was determined by alpha-particle spectroscopy to be $1.41 \pm 0.03 \times 10^{-5}$. The new value differs by almost 50% from an earlier one obtained by a less direct method. The use of 2% acetylene in Ar as a counting gas resulted in an improvement in resolution of gridded ion chambers used for alpha-particle spectroscopy. Resolutions of 0.28% (16 kev full width at half maximum) were obtained at counting geometries approaching 2π. (auth)

1563 (ORNL-P-514) NUCLEAR REACTIONS WITH HEAVY IONS. A. Zucker (Oak Ridge National Lab., Tenn.). Sept. 23, 1964. Contract W-7405-eng-26. 21p. (CONF-724-3). Dep.(mn); $1.00(cy), 1(mn) OTS.

From German Physical Society Conference, Dusseldorf, Ger., Oct. 1964.

The use of heavy ion reactions in studies of neutron transfer reactions and of the effects of angular momentum on the statistical decay of excited nuclei is discussed. (R.E.U.)

1564 (ORNL-TM-938) Q-VALUE OF THREE-BODY NUCLEAR REACTIONS. Mark Reeves, III (Oak Ridge National Lab., Tenn.). Oct. 1964. Contract W-7405-eng-26. 54p. Dep.(mn); $3.00(cy), 2(mn) OTS.

Q-values for nuclear reactions having three particles in the final state and the FORTRAN program from which these values were calculated are presented. Protons, deuterons, ^3He, and ^4He ions are considered as projectiles, and all stable nuclides for which $3 \leq Z \leq 20$ are used as targets. (auth)

1565 (ORNL-TM-964) SLATER INTEGRALS AND FORM FACTORS FOR INELASTIC SCATTERING USING REALISTIC SINGLE-PARTICLE WAVE FUNCTIONS: THE CODE ATHENA. M. B. Johnson and L. W. Owen (Oak Ridge National Lab., Tenn.). Oct. 12, 1964. Contract [W-7405-eng-26]. 14p. Dep.(mn); $1.00(cy), 1(mn) OTS.

A FORTRAN code was written for the IBM 7090 for computing Slater integrals and form factors suitable for inelastic scattering calculations, using single-particle wave functions that are eigenstates of motion in a Woods-Saxon potential well. Two-body forces of Gauss, Yukawa, double-Yukawa ("soft core"), and Coulomb radial dependence may be used. Non-local effects on the single-particle wave functions may be included in the local energy approximation. (auth)

1566 (PUC-1964-154) TOPICS CONCERNING COUPLED CHANNEL RESONANCES. L. Zamick (Princeton Univ., N. J. Palmer Physics Lab.). Oct. 6, 1964. Contract [AT(30-1)-937). 18p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The scattering of a particle by a target with two states, separated by an energy E_1, is considered. The coupled Schroedinger equation which results is solved on an IBM 7090-computer, and resonances due to the channel coupling are found. The behavior of the reaction matrix below and above threshold is examined. It is found that in addition to the narrow resonances below threshold, there are narrow anti-resonances above threshold. The anti-resonance structure is not present in the scattering matrix and hence is not experimentally observable. This is related to the Wigner limit on the rate of change of a phase shift with respect to wave number. The effect upon the width of a resonance of the surface thickness of a potential is considered. Both single-particle resonances and coupled channel resonances are considered. An example of an anomalous behavior in the coupled chan-

nel case is shown, where making the potentials more diffuse causes the reduced width of resonances to decrease. (auth)

1567 (RFR-223) SCATTERING CROSS SECTIONS FOR COPPER. H. Haeggblom (Aktiebolaget Atomenergi, Stockholm). 1963. 52p. Dep.(mn).

Elastic and inelastic scattering cross sections were calculated for ^{63}Cu and ^{65}Cu in the energy region 0.5 to 10 Mev, using the optical model program "Audrey 4" and Hauser-Feshbach theory for inelastic scattering. The latter is modified to assume jj-coupling, which is adequate when the hamiltonian includes spin-orbit interaction. Discrete excitation levels are assumed up to 1.75 Mev. Differential compound elastic cross sections are calculated up to the same energy. The sum of the compound elastic and shape elastic cross sections is given at different angles for the mixture 69% ^{63}Cu and 31% ^{65}Cu. This is approximately the composition of natural copper. Experimental values are given for comparison. The integrated cross sections above 0.5 Mev and the differential cross sections below 3 Mev agree satisfactorily with the experimental values. For the differential cross sections above 3 Mev, better agreement can be obtained by changing the optical model parameters, but this is not considered to be of importance for the actual application of the calculated cross sections. (auth)

1568 (TID-21113) STUDIES RELATING TO SCATTERING OF NEUTRONS AND ALLIED PHENOMENA. Annual Progress Report for 1964. D. M. Van Patter (Bartol Research Foundation, Swarthmore, Penna.). Sept. 25, 1964. Contract AT(30-1)-1679. 17p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Investigations of the γ-decay modes of many levels in ^{58}Ni and ^{60}Ni below 4 Mev excitation were made by observing $(p'-\gamma)$ coincidences. Angular distribution measurements for ^{60}Ni $(p,p'\gamma)$ radiations revealed an unusual case identified as a $3^+(E2,M1)2^+$ transition. The E2 decay of the 2.63 Mev 3^+ state to the second 2^+ state is at least 250 times greater than its E2 decay to the first 2^+ state in ^{60}Ni indicating its collective properties which would be characteristic of a three-phonon level. Non-resonant ground-state capture radiation was observed in a study of the ^{89}Y(p,γ) reaction in the vicinity of the 3^- isobaric spin analog state at $E_p = 5.02$ Mev. No resonant (p,γ_0) radiation was detected, but some increase at resonance was noted for a lower part of the γ-ray spectrum. Theoretical calculations concerning the partial equilibrium model for nuclear reactions included estimates of level spacings and widths of intermediate resonances as well as their effect on nuclear temperatures. Analysis of experimental yield data indicated that they could be classified into groups with the number of outer nucleons excited ranging from 5 to 7. Angular distributions for (p,p') and (p,α) reactions were calculated in the vicinity of an isolated intermediate resonance. It was discovered that $\gamma-\gamma$ angular correlations in ^{125}I and ^{127}I were substantially reduced using gaseous rather than solid xenon sources. This strong perturbation in the gaseous phase is attributed to the hyperfine interaction in the highly ionized xenon atoms formed after K-capture. Since the lifetime of the 203-kev level in ^{127}I is known to be about 5×10^{-10} sec, this observation yields an approximate lower limit of 300 Mc/sec for the average hyperfine structure constant $\langle a \rangle$. (auth)

1569 (TID-21195) SEARCH FOR THE RATIO OF POSITRON TO ELECTRON EMISSIONS FROM Rh^{102} WITH WILSON CLOUD CHAMBER (thesis). Madan Gopal Kaushish (Pennsylvania State Univ., University Park). Sept. 1962. 30p. Dep.(mn); $2.00(cy), 1(mn) OTS.

A 24-cm automatic Wilson cloud chamber was used in photographing the tracks of electrons and positrons emitted from a ^{102}Rh source. A complete description of the operation of the cloud chamber and the various accessories is given. The preparation of the ^{102}Rh source, the processing of the film, and the method of determining the energy of electrons and positrons are also discussed. The cloud chamber, at the present time, is suitable for the study of the phenomenon of multiple scattering of electrons and positrons in various gases. With slight modifications the cloud chamber can be used for other investigations using low-energy electrons and positrons. (auth)

1570 (TID-21201) GAMMA-GAMMA ANGULAR CORRELATION IN Ga^{71} (thesis). David Clarence Ghen (Pennsylvania State Univ., University Park). Dec. 1962. 56p. Dep.(mn); $3.00(cy), 2(mn) OTS.

The angular correlations for the three possible cascades in ^{71}Ga were measured, and the values of A_2 and A_4 reported for each case (A_2 and A_4 are used to determine the spins and multipolarities of the gamma cascade). The decay scheme of the ^{71}Zn isomers was taken from Thwaites and Pratt with unknown spins and multipolarities. (R.E.U.)

1571 (TID-21247) SENSITIVITY OF NUCLEAR MATTER BINDING ENERGY TO THE CHARACTERISTICS OF THE TWO-NUCLEON POTENTIAL (thesis). Nestor Jalil Azziz (Pennsylvania State Univ., University Park). Dec. 1963. 102p. Dep.(mn); $4.00(cy), 2(mn) OTS.

The Moszcowski and Scott approximation to the Brueckner many-body problem method for nuclear matter is discussed. The approximation is based on two observations: at short distances (less than 1 Fermi) the two nucleons do not feel the presence of nuclear matter; and for the long range part, the nucleon is strongly affected by other nucleons because of the Pauli principle. The two main potentials used in the calculations are the Brueckner-Gammel-Thaler and the Hamada-Johnston potentials; cutoff distance, binding energy and one-particle-potential, variations of the H-J potential, and a proposed two-nucleon model were considered. (R.E.U.)

1572 (UCRL-11663) PERTURBED ANGULAR CORRELATION MEASUREMENTS ON Ce^{140} AND Pr^{143} (thesis). Richard M. Levy (California. Univ., Berkeley. Dept. of Chemistry and California. Univ., Berkeley. Lawrence Radiation Lab.). Sept. 18, 1964. Contract W-7405-eng-48. 130p. Dep.(mn); $4.00(cy), 3(mn) OTS.

The interaction strength between the nuclear magnetic moment and the effective magnetic field at the nucleus was measured for the 2084-kev level in ^{140}Ce and the 57-kev level in ^{143}Pr by perturbed angular correlation of gamma radiation. For tetravalent Ce with a $4f^0$ configuration, the magnetic field at the nucleus is identical to the external field. This allows evaluation of the g-factor of the 2084-kev level as $g = 1.020 \pm 0.039$. The paramagnetic enhancement β due to one 4f electron for cerium in lanthanum metal gives $C_f = (114.3 \pm 16.1)°K$, where $\beta = 1 + (C/T)$. The level structure of ^{143}Pr was confirmed as $^7/_2$(0 kev), $^5/_2$(57 kev), and $^3/_2$(350 kev) by nuclear alignment and angular correlation. The perturbed angular correlation gives for the 57-kev level, $g = 1.73 \pm 0.09$. Comparison with data on metallic sources establishes the oxidation state of praseodymium in solution as 4+ during the nuclear lifetime. (auth)

1573 (UJV-1101/64) INTERNAL BREMSSTRAHLUNG BY 1ST FORBIDDEN BETA TRANSITIONS. F. Janouch and M. Havránek (Československá Akademie Věd. Ustav Jaderného Výzkumu, Řež). [1964]. 20p. Dep.(mn).

Spectrum shapes and circular polarization degree for allowed and first-forbidden internal bremsstrahlung (IBS) were investigated. Differences between allowed and forbidden IBS are discussed. It is shown that the spectrum shapes and circular polarization degree depend substantially on a β-transition energy. (auth)

1574 ALPHA ACTIVITY OF Sm-146. M. Nurmia, G. Graeffe, K. Valli, and J. Aaltonen (Univ. of Helsinki). Ann. Acad. Sci. Fennicae, Ser. A, VI, No. 148, 7p.(1964).

Samarium-146 was produced by the Sm-147(n,2n) and Sm-147(γ,n) reactions and also via Gd-146 and Eu-146 by irradiating Sm with He-3 ions. Its alpha energy was found to be (2.46 ± 0.02) Mev and the half life $(7.4 \pm 1.5) \times 10^7$ y. The possibility of observing Sm-146 on the earth as a result of supernova explosions is discussed. (auth)

1575 ON A FORMAL THEORY OF RESONANCE REACTIONS. Luciano Fonda (Universitã, Trieste, Italy and Istituto Nazionale di Fisica Nucleare, Trieste, Italy). Ann. Phys. (N. Y.), 29: 401-9(Oct. 5, 1964).

A complex potential model for the case of many overlapping narrow resonances is derived from a previously presented theory of resonance reactions, together with the decay law of the compound nuclear states. (D.C.W.)

1576 THE PRINCIPLE OF MINIMAL ENTROPY PRODUCTION IN DYNAMIC NUCLEAR POLARIZATION. Guenter Vojta (Arbeitsstelle fur Statistische Physik, Deutsche Akademie der Wissenschaften, Leipzig and Karl-Marx-Universität, Leipzig). Ann. Physik (7), 13: 342-50 (1964). (In German)

A simple derivation of the formulas for the stationary dynamic polarization of nuclear spin in the Overhauser, "Underhauser," Abragam-Jeffries, and solid effect was given by utilization of the concept of spin temperature. The principle of the minimal entropy production was indicated in a general manner within the spin temperature formalism for these effects. (tr-auth)

1577 MEASUREMENT OF THE β SPECTRA OF THE $2^- \rightarrow 2^+$ TRANSITION OF ^{42}K. Stéphane André and Pierre Depommier (Centre d'Etudes Nucleaires, Grenoble, France). Compt. Rend., 259: 1102-5(Aug. 3, 1964). (In French)

The β spectrum of the $2^- \rightarrow 2^+$ transition of ^{42}K to the first excited state of ^{42}Ca was measured in coincidence with the γ radiation at 1.52 Mev. The results showed a deviation of the order of 35% with respect to the statistical form. (tr-auth)

1578 NUCLEAR MAGNETIC RESONANCE OF ^{210}Hg ALIGNED BY OPTICAL PUMPING USING THE 1850-Å LINE. Ion M. Popescu and Leonid N. Novikov (Université, Paris). Compt. Rend., 259: 1321-4(Aug. 10, 1964). (In French)

Optical pumping by the resonance ray of the 1850-Å singlet was used to produce nuclear alignment of ^{201}Hg, and to study the nuclear magnetic resonance of this isotope. (tr-auth)

1579 CROSS SECTIONS FOR PRODUCTION OF BERYLLIUM-7 IN ALUMINUM, VANADIUM, TANTALUM, AND GOLD BY PROTONS OF 155 AND 550 Mev. Marguerite Ligonniere, Brigitte Vassent, and Rene Bernas (Université de Paris, Orsay, France). Compt. Rend., 259: 1406-8(Aug. 17, 1964). (In French)

Cross sections for the production of ^{7}Be by protons in Al, V, Ta, and Au were measured at 155 Mev. The cross section for gold was also measured at 550 Mev. The chemical separation methods used are briefly described. The values obtained for Al, V, Ta, and Au are 1.0 ± 0.2, 0.23 ± 0.04, 0.042 ± 0.008, 0.033 ± 0.008, and 0.35 ± 0.05 mbarn, respectively. (tr-auth)

1580 AN ANALYSIS OF THE PHOTOPRODUCTION OF POSITIVE PIONS AT PHOTON ENERGIES OF 175 TO 230 Mev. M. I. Adamovich, V. G. Larionova, A. I. Lebedev S. P. Kharlamov, and F. R. Yagudina (Lebedev Inst. of Physics, Moscow). Dokl. Akad. Nauk SSSR, 158: 309-12 (Sept. 11, 1964). (In Russian)

A high-energy bremsstrahlung photon beam struck a liquid hydrogen target. A nuclear emulsion pile was used as a pion detector. All the π-μ-decays were recorded, and also for additional control, the endings of the μ-meson tracks and of the pion tracks were recorded. The differential cross-section $d\sigma/d\Omega$ for the photoproduction of pions was measured over 9 angles at photon energies of 175 to 230 Mev at 5 Mev intervals. The term $(k/q)\ (d\sigma/d\Omega)\ (\theta = 90°)$ is plotted as a function of q^2. Here θ is the angle of pion emission in the center-of-mass system, and k, q are the momenta of the photon and pion expressed in units of $\hbar = \mu = c = 1$. The data agree with the data of others. The agreement between the theoretical values based on dispersion relationships and experiment is satisfactory for $\theta = 90°$. However, this agreement is not observed for all amplitudes. The formation of pions in the D-state has an effect on the angular distribution of the pions. The constant A of the γ-π-p-interaction has an effect on the amplitude scattering. (TTT)

1581 A MODIFIED WKB APPROXIMATION FOR PHASE SHIFTS. Mervine Rosen (Univ. of Minnesota, Minneapolis and Naval Research Lab., Washington, D. C.) and Donald R. Yennie. J. Math. Phys. (N. Y.), 5: 1505-15(Nov. 1964).

Extending an idea of Good, a modified WKB approximation using radial wavefunctions having the form of free-particle solutions to the radial wave equation rather than an exponential form is developed. The lowest-order phase shifts are the same as those of the usual WKB approximation, but are improved by the contribution of the next order. The method is applied to two examples: the radial Dirac equation in the high-energy limit and the radial Schrödinger equation. (auth)

1582 RELATIVISTIC COULOMB SCATTERING OF ELECTRONS. R. L. Gluckstern and Shin-R Lin (Yale Univ., New Haven). J. Math. Phys. (N. Y.), 5: 1594-1602 (Nov. 1964).

A simple and useful relation between the Coulomb amplitudes F and G (in Mott's notation) is derived and F and G are evaluated analytically up to α^4 terms for arbitrary $q = \alpha/\beta$. These results are valid for all angles, but are particularly useful at small angles. The general analytic behavior of F and G in the variable $x = \sin \frac{1}{2}\theta$ is discussed. The method is applicable to higher-order terms (α^6 and up). A double integral representation of F is also derived by using the Sommerfeld-Watson transformation. This integral representation exhibits the dependence on α, q, and θ separately. (auth)

1583 SPALLATION REACTIONS (p,αxn) ON HEAVY NUCLEI. Bernard Gatty and Xavier Tarrago (Faculte des Sciences, Paris). J. Phys. (Paris), 25: 725-30(July 1964). (In French)

The cross sections for excited nuclides formed through (p,α) (p,αn) and (p,α2n) interactions on thorium target nuclei are calculated. The computation is based on quasi-elastic scattering of prompt cascade nucleons on alpha clusters on the nucleus surface. In addition, the excitation energy distribution is obtained for the excited ^{227}Ac, ^{228}Ac, and ^{229}Ac nuclides. Therefore the evaporation probability for the emission of j neutrons and the residual nuclide cross sections are available. Fair agreement was found between these results and the experimental data at several incident energies and for all the j values investigated. (auth)

1584 FORMATION CROSS SECTION FOR THE PROTACTINIUM ISOTOPE OF MASS 226 PRODUCED IN THORIUM BY PROTONS AT 155 Mev. M. Hussonnois (Institut du Radium, Orsay, France). J. Phys. (Paris), 25: 747-8 (July 1964). (In French)

The cross section of ^{226}Pa production by the ^{232}Th(p,7n) reaction for 155-Mev protons, obtained by comparison with ^{227}Pa, is 1 ± 0.3 mb. (auth)

1585 DISSYMMETRIC BREAKUP OF THE ACTIVATED NUCLEAR COMPLEX PRODUCED BY ^{6}Li. A. Garin (CEN, Saclay, France), C. Lemeille, D. Manesse, L. Marquez, N. Saunier, and J. L. Quebert. J. Phys. (Paris), 25: 768-72(July 1964). (In French)

The continuous spectra of alpha particles coming from the reactions ^{6}Li + ^{6}Li, ^{6}Li + ^{7}Li, and ^{6}Li + ^{10}B are studied. We iffer that the ^{6}Li makes with the target an activated complex which decays via the dissymmetric breakup. All the measured spectra can be explained quantitatively. (auth)

1586 LANTHANUM-140 AND CERIUM-144 AS MONITORS FOR NUCLEAR FISSION WITH THERMAL NEUTRONS IN URANIUM-235. P. Markl and F. Hecht (Universität, Vienna). Monatsh. Chem., 95: 884-909(1964). (In German)

With the help of the recently attempted use of HDEHP (Di(2-ethylhexyl)phosphoric acid) for carrier-free extraction of rare earths from fission products, the possibility

was investigated for use of isotopes of the rare earth series as secondary monitors for determination of the number of fissions in a ^{235}U-containing sample. From observation of the fission yield and half lives of the originating fission products it was concluded that after a minimum cooling time of 10 days ^{140}La and the mixture of cerium isotopes are available for such a use. The extraction was followed up on the basis of gamma spectra and the purity of the obtained fraction was investigated by gamma spectroscopy and by electrophoretic ion focusing. It is shown that the ^{140}Ba impurity does not disturb the use of the ^{140}La peak at 1.597 Mev. For determination of the ^{144}Ce content the 2.98-Mev beta particle from ^{144}Pr equilibrium activity was measured. The results indicated that this method can be successfully used for monitoring ^{235}U fission. (tr-auth)

1587 MEASUREMENT OF THE UNEQUAL LINE WIDTHS AND RECOILLESS FRACTIONS OF SOURCE AND ABSORBER IN NUCLEAR RESONANCE. D. A. O'Connor and G. Longworth (Univ. of Birmingham, Eng.). Nucl. Instr. Methods, 30: 290-2(Nov. 11, 1964).

The theoretical analysis of O'Connor was used to determine the parameters of an ^{57}Fe Mössbauer source and several absorbers. Values for the recoilless fractions at room temperature of the source and natural iron absorbers, of 0.77 ± 0.02 and 0.76 ± 0.06, respectively, were obtained; and the ratios of the natural width of source and absorbers to the observed widths were found to be 0.45 ± 0.03 and 0.85 ± 0.05, respectively. Anomalous results obtained for a highly enriched ^{57}Fe absorber are explained in terms of a difference in magnetic hyperfine splitting between source and absorber. (auth)

1588 A CALCULATION OF SOME $\Delta K = \pm 2$ BAND-MIXING EFFECTS IN THE ODD-MASS NUCLEUS W^{183}. D. J. Rowe (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Nucl. Phys., 61: 1-12(Jan. 1965).

An attempt is made to find out whether the $\Delta K = \pm 2$ band-mixing interactions play any part in the mixing of rotational bands in odd-mass nuclei, as they do in even nuclei. The amount of such an interaction in the ^{183}W Hamiltonian is found to be either very small, or small, corresponding to the two solutions for which good fits to the energy level spectra were obtained. Both solutions also fit very well the known branching ratios for the gamma-ray decay of the excited states, but only the first solution gives good agreement with the B(E2) values obtained from Coulomb excitation experiments. It thus seems highly probable that only a very small amount of the $\Delta K = \pm 2$ interactions are present, and while these are important in giving an excellent fit to the energy levels, they have a negligible effect on the wave functions and hence on the electromagnetic transition strengths. (auth)

1589 FURTHER PRECISION GAMMA RAY MEASUREMENTS WITH A SCINTILLATION SPECTROMETER. K. W. Marlow (Naval Research Lab., Washington, D. C.). Nucl. Phys., 61: 13-16(Jan. 1965).

As a continuation of previous work, several gamma ray energies were measured with a precision scintillation spectrometer. Gamma rays from ^{69}Zn, ^{27}Mg, ^{86}Rb, ^{65}Zn, ^{22}Na, and ^{41}Ar were measured to an accuracy of the order of 1 kev. (auth)

1590 RADIOCHEMICAL STUDY OF THE COMPETITION BETWEEN NEUTRON EMISSION AND FISSION IN U^{238} AT DISCRETE EXCITATIONS NEAR THE BINDING ENERGY. Manfred Lindner (Weizmann Inst. of Science, Rehovoth, Israel). Nucl. Phys., 61: 17-24(Jan. 1965). (UCRL-7662)

Photoneutron emission and photofission in ^{238}U near the neutron separation energy were investigated radiochemically. The source of the photoexcitation was gamma radiation produced by thermal-neutron capture in selected metals placed in the thermal column of a 2-Mw nuclear reactor. By varying the choice of the neutron-capturing source, the effective photon energy was changed so that the competing photonuclear reactions could be studied at different discrete excitations in ^{238}U. Within the accuracy of the measurements, no definite change in the ratio of the neutron-emission-to-fission widths in ^{238}U was noticeable in the energy region from 6 to 9 Mev. (auth)

1591 GAMMA RAYS FOLLOWING INTERMEDIATE ENERGY PROTON BOMBARDMENTS AND COLLECTIVE STATES IN Ba^{130}. K. Miyano (Tokyo Univ.), M. Ishihara, Y. Shida, H. Morinaga, T. Kuroyanagi, and T. Tamura. Nucl. Phys., 61: 25-32(Jan. 1965).

Low-energy gamma rays generated by bombardments with 27 to 50 Mev protons were studied. In a tantalum bombardment, the rotational states were observed up to the 10^+ state in ^{170}W, the (p,4n) product. In a series of bombardments of cesium targets, states were observed in ^{130}Ba with spin values up to 6. The results are compared with results in the neighboring region studied with the aid of beta-gamma spectroscopy. (auth)

1592 LIFETIME OF THE 100 kev 2^+ AND THE 1290 kev 2^- STATES IN W^{182}. M. Dorikens, O. Segaert, J. Demuynck, and L. Dorikens-Vanpraet (Rijksuniversiteit, Ghent). Nucl. Phys., 61: 33-5(Jan. 1965).

The half lives of the 100-kev 2^+ state and the 1290-kev 2^- state in ^{182}W were measured by the delayed coincidence technique. A non-linear least-squares analysis showed a value $T_{1/2} = 1.39 \pm 0.03$ nsec for the 100-kev state and 1.03 ± 0.03 nsec for the 1290-kev state. (auth)

1593 THE EFFECT OF THE 3.10 Mev STATE OF F^{17} ON THE O^{16}(p,γ) REACTION. John J. Domingo (California Inst. of Tech., Pasadena). Nucl. Phys., 61: 39-55(Jan. 1965).

The yields of the two capture gamma rays in the ^{16}O(p,γ) reaction have been measured at 90° to the beam for bombarding energies in the range 2.56 to 2.76 Mev. An anomaly was observed in the yield of the capture gamma ray leading to the 0.500-Mev $\frac{1}{2}^+$ state of ^{17}F. No anomaly was observed in the yield of the capture gamma ray leading to the $\frac{5}{2}^+$ ground state of ^{17}F. The experimental results were found to agree with theoretical calculations made on the basis of the extranuclear capture model. On the basis of the experimental results and these calculations, the single-particle reduced widths for the $\frac{1}{2}^+$ 0.500-Mev state and the $\frac{5}{2}^+$ ground state of ^{17}F were determined. From the shape of the anomaly observed in the yield of the capture gamma ray leading to the $\frac{1}{2}^+$ state and the extranuclear calculations, an upper limit was placed upon the width of the gamma ray transition leading from the resonant $\frac{1}{2}^-$ state at 3.10 Mev to the $\frac{1}{2}^+$ 0.500-Mev state. This limit was $\Gamma_\gamma < 0.03$ ev. (auth)

1594 THE DECAY OF Sr^{93} AND THE GAMMA SPECTRUM OF Y^{93}. H. Bakhru and S. K. Mukherjee (Saha Inst. of Nuclear Physics, Calcutta). Nucl. Phys., 61: 56-64(Jan. 1965).

The ^{93}Sr nucleus is produced by the ^{96}Zr(n,α)^{93}Sr reaction with 14.5-Mev neutrons, and is studied by means of standard spectroscopy techniques. A quick and efficient method for radiochemical separation of Sr from Zr and Y has been developed. The beta and gamma measurements show three beta groups of maximum energies 2.9 ± 0.05 Mev (65%), 2.6 ± 0.05 Mev (25%), and 2.2 ± 0.05 Mev (10%) and eight gamma rays of energies 0.305, 0.400, 0.600, 0.800, 1.10, 1.50, 1.70, and 2.1 Mev. Coincidence studies show that the 0.600-Mev gamma ray is in coincidence with 0.305, 0.400, 0.800, 1.1, and 1.5-Mev gamma rays; the 0.800-Mev gamma ray with 0.305, 0.400, and 0.600-Mev gamma rays; the 1.1-Mev gamma ray with 0.400 and 0.600-Mev gamma rays; and the 1.7-Mev gamma ray with the 0.400-Mev gamma ray only. Also with the 0.600 and 0.800-Mev gamma rays in the gate, all the three beta groups are observed; with the 1.1 and 1.7-Mev gamma rays, two beta groups of maximum energies 2.6 and 2.2 Mev are observed; and with the 1.5 and 2.1-Mev gamma rays only the beta group of energy 2.2 Mev appears. Based on the above observations, a decay scheme of ^{93}Sr is proposed. (auth)

1595 OBSERVATION OF DIPOLE-OCTUPOLE MIXTURE IN THE GAMMA-DECAY OF THE 1174 kev ISOMERIC STATE OF Yb^{172} AND ITS MAGNETIC MOMENT.

C. Guenther, H. Blumberg, W. Engels, G. Strube, J. Voss, R.-M. Lieder, H. Luig, and E. Bodenstedt (Universität, Bonn). Nucl. Phys., 61: 65-86(Jan. 1965).

Measurements of $\gamma\gamma$ angular correlations in the decay of ^{172}Lu revealed that the 1095-kev γ transition has the unusual multipole mixture of 95% dipole radiation with 5% octupole radiation. This transition is strongly retarded by the K selection rule. We determined the half life of the 1174-kev state as $T_{1/2} = 8.4 \pm 0.3$ nsec. The g factor of the state has been measured by applying the spin rotation method. The result $g = +0.214 \pm 0.014$ was compared with the predictions of the Nilsson model. The best fit was obtained for the two-neutron configuration $[514\downarrow - 521\downarrow]$. The g factor measurement, as well as additional $\gamma\gamma$ angular correlation measurements, favor the assignment of a positive parity to the isomeric state. Angular correlation measurements of the 901 kev–1095 kev cascade and the 811 kev–91 kev–1095 kev triple cascade agree with the assignment of the spin I = 4 to the 2075-kev state; only the spin I = 2 cannot be excluded. The angular correlations are slightly attenuated by interactions with the strong fields of the unfilled 4f electronic shell. We derived the spin relaxation time of the 4f shell as $\tau_1 = (2.0 \pm 0.5) \cdot 10^{-13}$ sec. This result was obtained for liquid sourced of $LuCl_3$ solved in dilute hydrochloric acid. (auth)

1596 ANALYSIS OF THE BETA-DECAY OF Bi^{210}(RaE). J. P. Deutsch and P. Lipnik (Université, Louvain, Belg.). Nucl. Phys., 61: 97-109(Jan. 1965).

On the basis of electron longitudinal polarization measurements and high-accuracy spectrum-shape measurements, the beta decay of ^{210}Bi and a critical survey of earlier attempts are given. In particular, a χ^2-test is performed to characterize numerically the goodness of the best fit that can be obtained between theoretical values and experimental results. Relying on the stated experimental errors only, one can find no really satisfactory fit between the theory and the spectrum-shape measurements alone. The best fit to both spectrum-shape and polarization measurements cannot be obtained by the same set of nuclear matrix elements. The best compromise which can be obtained between fits to spectrum-shape and polarization measurements is in agreement with the predictions of the conserved vector-current theory of weak interaction. In particular, there does not seem to be any need to introduce different effective radii for different nuclear matrix elements. The best fit can be obtained on the assumption that the odd neutron of ^{210}Bi is in a mixture of $11_{9/2}$ and $2g_{9/2}$ states in a specified ratio. (auth)

1597 USING EXACT ELECTRON BETA DECAY THEORY RADIAL WAVE FUNCTIONS. III. THE INFLUENCE OF SCREENING. Wolfgang Buehring (Universität, Heidelberg). Nucl. Phys., 61: 110-28(Jan. 1965).

In order to investigate the influence of screening on beta decay functions, a method based on power series expansions is described for calculating continuum state solutions of the Dirac radial equations containing a sufficiently general potential. Tables of beta decay functions for beta spectra, electron polarization, and beta-gamma correlations calculated with a screened potential are given. Ratios of these values to values without screening are also included. (auth)

1598 NEW SHORT-LIVED ISOMERIC LEVELS IN Tl^{201m} AND Tb^{153m}. V. T. Gritsyna and H. H. Forster (Univ. of Southern California, Los Angeles). Nucl. Phys., 61: 129-37(Jan. 1965).

Isomeric levels in thallium and terbium isotopes in the msec range were studied by examining the gamma de-excitation spectra following the bombardment of Hg and Gd isotopes with 30.5-Mev protons. An isomeric level was identified in ^{201m}Tl both from the ^{201}Hg(p,n)^{201m}Tl and ^{204}Hg(p,4n)^{201m}Tl reaction, with a half life $\tau = 1.8 \pm 0.1$ msec. The gamma spectrum of the isomer showed three prominent lines with energies of 0.225 ± 0.010, 0.325 ± 0.010, and 0.585 ± 0.010 Mev. A level scheme with a spin of $9/2^-$ for the isomeric level is suggested for ^{201m}Tl. An isomeric activity was found in ^{153m}Tb from the ^{154}Gd(p,2n)^{153m}Tb and ^{156}Gd(p,3n)^{153m}Tb reactions with a half life $\tau = 0.173 \pm 0.010$ msec and $E_\gamma = 0.078 \pm 0.005$ Mev. (auth)

1599 α-WIDTHS FOR C^{12} AND THE PURITY OF SHELL MODEL LEVELS. V. V. Balashov and I. Rotter (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Phys., 61: 138-44(Jan. 1965).

The reduced α-widths for some levels of ^{12}C are calculated in the framework of the shell model with intermediate coupling. A classification of α-transitions with regard to the permutation symmetry of the wave function is given. A comparison of calculated and experimental α-widths shows that for ^{12}C the shell model gives values in the right order of magnitude only for those levels in which no mixing with cluster levels takes place (levels 1^+). For all other levels the calculated θ_α^2 values are less than the experimental ones. An explanation is suggested in terms of mixing of shell model levels with levels of a collective nature. (auth)

1600 THE ELECTRON-PHOTON CASCADE IN LEAD, EMULSION AND COPPER ABSORBERS. D. F. Crawford and H. Messel (Univ. of Sydney). Nucl. Phys., 61: 145-72 (Jan. 1965).

Monte Carlo calculations of the electron-photon cascade in lead, emulsion, and copper have been done for electron and photon primaries of energy 50, 100, 200, 500, 1000, and 2000 Mev. Electron and photon secondaries were counted for energies greater than 10, 20, 50, 100, 200, 500, and 1000 Mev. The one dimensional means and variances are given with an index to unpublished tables. (auth)

1601 ODD-EVEN EFFECT IN THE NUCLEAR LEVEL DENSITY AND SUPERFLUID MODEL OF NUCLEI. G. G. Vittorio Canuto and Leopoldo S. Garcia-Colin (Centro de Investigacion y de Estudios Avanzados, Mexico City). Nucl. Phys., 61: 177-93(Jan. 1965).

The superfluid model of nuclei as worked out by Belyaev is used to account for the observed variation of the nuclear level density amongst odd, odd-mass, and even nuclei. (auth)

1602 THE Ca^{40}(d,p)Ca^{41} REACTION. S. Rusk and C. M. Class (Rice Univ., Houston, Tex.). Nucl. Phys., 61: 209-18(Jan. 1965). (TID-20752)

The spectra and angular distributions of protons emitted in the ^{40}Ca(d,p)^{41}Ca reaction were measured with low-energy resolution at bombarding energies of 4.1 and 4.7 Mev. Eight peaks were resolved in the spectra of which four are identified with transitions to well-known states of large reduced widths at energies of 0, 1.95, 2.47 and 3.95 Mev in ^{41}Ca. The four remaining peaks and a fifth for which weaker evidence exists, are identified with transitions to groups of states in ^{41}Ca at mean energies of 4.79, 5.08 (weak evidence), 5.48, 5.76 and 6.04 Mev. The angular distributions of the protons identified with seven of the promenent peaks were measured. Those obtained for the four states of lower energy are compared to the angular distributions given by the DWBA calculations of Tobocman and Gibbs. The l values of the captured neutrons required to fit the data in these calculations were (beginning with the ground state) 3, 1, 1 and 1, respectively, confirming assignments made or suggested in earlier investigations. Unique l value assignments for the composite states of higher energy were not possible, the angular distributions generally showing only broad maxima at forward angles. Some understanding of the nature of the states responsible for the gross features of the data at excitation energies above 4 Mev has been obtained by comparison with states in the mirror nucleus ^{41}Sc. (auth)

1603 THE OPTICAL POTENTIALS FOR COMPOSITE PARTICLES. J. R. Rook (Oxford Univ.). Nucl. Phys., 61: 219-24(Jan. 1965).

It is pointed out that the depths of the real parts of the optical potentials for deuterons, tritons, and alpha particles are expected theoretically to be approximately 100, 150 and 200 Mev, respectively, and that such potentials account for the data on elastic scattering of these projectiles. The effects of the use of such potentials in the analysis of (t,p) reactions are discussed. (auth)

1604 ROTATIONAL SPECTRA OF NUCLEI WITH SMALL ASYMMETRY. P. Banerjee and S. Sengupta (Presidency Coll., Calcutta). Nucl. Phys., 61: 225-34 (Jan. 1965).

Energy levels of an asymmetric rotator are described in terms of the three parameters $\mathcal{I}$, α_1 and α_2 which are derived from the three principal moments of inertia $\mathcal{I}_1$, $\mathcal{I}_2$ and $\mathcal{I}_3$. It is shown that in the limit of $\alpha_1 \to \infty$ or $\mathcal{I}_3 \to 0$, the asymmetry has no effect on the energy levels. When $\alpha_1 \gg 1$ the effect of asymmetry is generally small for moderate values of the asymmetry parameter α_2. A perturbation formula is developed for the energy levels in such cases and it is shown that for a large number of nuclei the low-lying levels are well reproduced by a suitable choice of the parameters. The best fit values of these parameters are tabulated. A critical examination shows that the parameters are represented neither by the rigid nor by the hydrodynamical model. It is noticed however, that while $\mathcal{I}$ is closer to the rigid value, $\mathcal{I}_3$ appears to be closer to the hydrodynamical value. This may explain the failure of a semi-empirical model in which the moments of inertia are given values intermediate between the rigid and the hydrodynamical moments of inertia. (auth)

1605 THE $N^{14}(d,\alpha_0)C^{12}$ AND $N^{14}(d,\alpha_1)C^{12*}$ REACTIONS AT DEUTERON ENERGIES OF ABOUT 1 Mev. D. M. Stanojević, N. R. Berović, and F. M. Boreli (Inst. of Nuclear Science "Boris Kidrich", Belgrade). Nucl. Phys., 61: 235-40(Jan. 1965).

The angular distributions of the ground-state and first-excited-state alpha groups from the $^{14}N(d,\alpha)^{12}C$ reaction at five deuteron energies, ranging from 0.9 to 1.2 Mev, were measured. The observed angular distributions do not show symmetry around 90°, particularly in the case of the α_0 group. The experimental data were analyzed in terms of Legendre polynomials. (auth)

1606 ABSOLUTE $\log_{10}$ft VALUES FOR THE FIRST-FORBIDDEN TRANSITIONS OF THE ODD-MASS NUCLEI IN THE 150 < A < 190 REGION. D. Bogdan (Inst. for Atomic Physics, Bucharest). Nucl. Phys., 61: 241-9(Jan. 1965).

Absolute $\log_{10}(f_c t)_R$ values were calculated for first-forbidden transitions of the odd-mass nuclei in the 150 < A < 190 region by means of the formula $(f_c t)_R = \pi^3 \ln 2/|\eta|^2 R$. The R^{-1} factor represents the correction given by the superfluid model. Only the transitions for which $J_i + J_f \geq 2$ were taken into account and therefore the expression $\eta = C_A \int B_{ij}$ was used as standard matrix element. In some cases the theoretical $\log_{10}(f_c t)_R$ values are approximately equal to the experimental $\log_{10}(ft)_{exp}$ values. In most cases in which the theoretical $\log_{10}(f_c t)_R$ values are sensibly larger than the usual ones, the Kotani corrective term $\log_{10}[f_c^{(0)}/f_0(0)]$ was also calculated and was found sufficiently large to permit the conclusion that also in these cases the superfluid model correction improved the theoretical values. But in general the agreement between theory and experiment is not satisfactory; the experimental corrected values are systematically greater than the theoretical ones. (auth)

1607 THE ISOMERIC DECAYS OF Ag^{108m} AND Ag^{110m}. J. H. Hamilton (Instituut voor Kernphysisch Onderzock, Amsterdam), J. F. W. Jansen, P. F. A. Goudsmit, and A. R. Sattler. Nucl. Phys., 61: 257-63(Jan. 1965).

The electron spectrum in the range 1 to 29 kev and 48 to 120 kev from the decay of ^{110m}Ag was studied in an iron-free, double-focusing spectrometer. The K/L ratio of the 116-kev isomeric transition in the decay of ^{110m}Ag to ^{110}Ag was measured to be 1.95 ± 0.10 and the L/(M + N + O) ratio to be 4.0 ± 1.0. These data help to confirm the M4 character of the 116-kev transition. No evidence for the proposed E1 transition of 20 to 30 kev which should follow the 116-kev transition was found. An upper limit of 4-kev was placed for the energy of this proposed transition. The 30.2-kev transition from the decay of ^{108m}Ag was observed. The K/L ratio is less than 0.3 which is consistent with an E3 or higher multipole transition. (auth)

1608 THE MULTIPOLARITY OF THE 116 kev ISOMERIC TRANSITION IN Ag^{110}. J. S. Geiger (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nucl. Phys., 61: 264-8(Jan. 1965).

The internal conversion lines of the 116-kev isomeric transition in the ^{110m}Ag decay have been studied using the Chalk River $\pi\sqrt{2}$ β-spectrometer. The measured conversion line intensity ratios are $K/\Sigma L/\Sigma M/\Sigma(N + O) = 2.04 \pm 0.06/1/0.214 \pm 0.008/0.036 \pm 0.003$, $L_I/L_{II} = 4.81 \pm 0.45$ and $L_I/L_{III} = 1.02 \pm 0.02$. The transition energy is 116.410 ± 0.015 kev. The K/ΣL ratio is in agreement with published values and supports the M4 multipolarity assignment to this transition. The measured L line intensity ratios agree with the corresponding theoretical ratios from Sliv and Band for M4 radiation and confirm the multipolarity assignment. The problem presented by the inconsistency of this multipolarity assignment with the spins of ^{110m}Ag and ^{110}Ag is discussed. (auth)

1609 THE ELECTRIC DIPOLE RESONANCE OF ^{13}C AND ^{13}N. D. F. Measday, A. B. Clegg, and P. S. Fisher (Oxford Univ.). Nucl. Phys., 61: 269-81(Jan. 1965).

The available experimental information about the electric dipole resonance of ^{13}C and ^{13}N is analyzed, showing the difference between the dipole resonance in these (4n + 1) nuclei and those in the 4n nuclei which have been studied more frequently. Comparison of (γ,n) and (γ,p) cross sections should determine the isobaric spins of the components of the resonance. The measurements fit most simply with all three components having $T = \frac{1}{2}$. However, simple considerations about the structure of ^{13}C and ^{13}N show that an important part of the resonance should have $T = \frac{3}{2}$. It is shown that is is possible that the 26-Mev resonance can be basically $T = \frac{3}{2}$ with a not too large admixture of a $T = \frac{1}{2}$ state with particular properties. A simple weak-coupling model is studied in which the ground states of ^{13}C and ^{13}N are made by coupling a nucleon to the ground state of ^{12}C, and it is shown how cross sections deduced for the $^{13}N(\gamma,p_0)$ reaction are consistent with being due to the excitation of the extra nucleon in such a model. A more general shell-model calculation, due to Easlea, is discussed, showing that its conclusions probably do not agree with the conclusions about the $^{13}N(\gamma,p_0)$ measurements. Approximations in this calculation are indicated which could perhaps be the cause of this discrepancy. This weak-coupling model makes further predictions about the modes of breakup of the ^{13}C, ^{13}N dipole resonance. (auth)

1610 THE (d,α) REACTION OF F^{19}. A. Z. El-Behay, M. A. Farouk, M. H. Nassef, and I. I. Zaloubovsky (Atomic Energy Establishment, Cairo). Nucl. Phys., 61: 282-8(Jan. 1965).

Angular distributions and excitation functions of α particles from the reaction $^{19}F(d,\alpha)^{17}O$ leading to the ground and first nine excited final states have been studied in the deuteron energy region from 1 to 2.5 Mev. The emitted α particles were detected with a semiconductor detector. Broad intensive maxima were observed at certain deuteron energies in the excitation function of all α groups. Angular distributions were measured at deuteron energies corresponding to the maxima and minima of excitation functions. In most cases angular distributions of different α groups show characteristic features of the compound nucleus mechanism. The absolute values of differential and integral cross-sections have been obtained for all α groups. (auth)

1611 ENERGY LEVELS OF Ar^{36} AND Ar^{38}. R. G. Allas, L. Meyer-Schuetzmeister, and D. Von Ehrenstein (Argonne National Lab., Ill.). Nucl. Phys., 61: 289-96 (Jan. 1965).

The energy-level schemes of ^{36}Ar and ^{38}Ar were measured up to excitation energies of 8.3 and 6.9 Mev, respectively. The reactions $^{39}K(p,\alpha)^{36}Ar$ and $^{41}K(p,\alpha)^{38}Ar$ were used, and the α-particle groups leading to the different states in ^{36}Ar and ^{38}Ar were studied. Many more states in both nuclei than were known previously were found, in particular, closely spaced levels lying less than 100 kev

apart are rather numerous in ^{36}Ar. Each of these nuclei shows a complicated energy-level scheme which cannot be explained solely by the excitation of the nucleons in the $2s_{\frac{1}{2}}$ and the $1d_{\frac{3}{2}}$ shells. (auth)

1612 NUCLEAR REACTIONS OF Ne^{21} WITH PROTONS AND α PARTICLES. N. W. Tanner (Oxford Univ.). Nucl. Phys., 61: 297-302(Jan. 1965).

The reaction $^{21}Ne(p,\gamma)^{22}Na$ was studied between E_p = 0.3 and 1.0 Mev using a NaI scintillation counter. Two resonances were observed at 0.766 and 0.520 Mev. The former radiates both to the ground state and to one of the ^{22}Na excited states near 0.6 Mev; rough angular distribution measurements indicated $J^\pi = 2^-$ as a probable assignment for the resonance. The 0.520-Mev resonance radiates to the ^{22}Na states at 0.89 and 1.99 Mev with a total radiation width of ≈10 ev. It seems unlikely that there are any other resonances of $^{21}Ne(p,\gamma)^{22}Na$ in the range covered with radiation widths in excess of 5 ev. The reaction $^{21}Ne(\alpha,n)^{24}Mg$ has been observed for the first time and has been identified by resonances at E_α = 2.10 and 2.58 Mev in the neutron yield detected by a "Hornyak counter." The reaction has been confirmed by the observation with a NaI counter of a 1.36 ± 0.02 Mev γ-ray which is believed to arise from the first excited state of ^{24}Mg at 1.37 Mev. (auth)

1613 DISPERSION THEORY AND THE NUCLEAR MANY-BODY PROBLEM. C. D. Froggatt (Cambridge Univ., Eng.). Nucl. Phys., 61: 303-15(Jan. 1965).

The Hartree self-consistency equations are derived as the nonrelativistic, no-recoil limit of the dispersion analysis of nuclear electromagnetic form factors described by Eden and Goldstone. A class of internucleon potentials is found, for which the iterative solution of these equations is convergent and retains the essential analyticity properties of dispersion theory. (auth)

1614 RECOIL STUDIES IN DISINTEGRATIONS EMITTING ENERGETIC HEAVY FRAGMENTS. F. O. Breivik, T. Jacobsen, and S. O. Soerensen (Universitet, Oslo). Nucl. Phys., 61: 321-5(Jan. 1965).

Measurements are presented of range spectra, angular distributions etc. of short tracks ($\lesssim$10 μm) in nuclear emulsions from disintegrations produced by 4.5-Bev negative pions. A tendency is observed of these tracks to be backward collimated with respect to the primary in stars emitting heavy nuclear fragments (Li, Be, B). (auth)

1615 THE EMISSION OF PROTONS FROM LIGHT NEUTRON-DEFICIENT NUCLEI. Joachim Jaenecke (Technische Hochschule, Karlsruhe and Kernforschungszentrums, Karlsruhe, Ger.). Nucl. Phys., 61: 326-40(Jan. 1965).

The properties of the processes which lead to the emission of protons from light neutron-deficient nuclei are discussed. These processes are in particular proton decay, double proton decay, and β-delayed emission of protons and di-protons. Masses of light nuclei with Z $\leqq$ 14 were calculated, and a limit of stability with regard to the emission of protons is given. Candidates for double proton decay are the following light even-Z nuclei: ^{12}O, ^{16}Ne, ^{19}Mg and possibly ^{23}Si. The β-delayed emission of protons should occur subsequently to the β^+-decays of ^{9}C, ^{17}Ne, (^{19}Mg) and ^{20}Mg. Emission of weak proton groups may also follow the β^+-decays of (^{12}O), ^{13}O, ^{21}Mg, ^{24}Si and ^{25}Si. Several of these proton groups have been observed. The findings of this paper supplement and extend previous predictions. (auth)

1616 ANALYSIS OF RESONANCE PARAMETERS OF COBALT FOR NEUTRONS OF ENERGY BELOW 30 kev. J. Morgenstern, G. Bianchi, C. Corge, V.-D. Huynh, J. Julien, F. Netter, G. Le Poittevin, and M. Vastel (Centre d'Etudes Nucleaires, Saclay, France). Nucl. Phys., 61: 342-53(Jan. 1965). (In French)

The total neutron cross section of ^{59}Co was measured with a resolution of 0.8 ns/m up to an energy of 60 kev. The parameters of the resonances below 30 kev were determined by means of the single-level Breit-Wigner formula using a shape analysis. The value of the s wave neutron strength function $\overline{\Gamma_n^0}/D$ is found to be (6.7 ± 3.3) × 10^{-4} $ev^{-\frac{1}{2}}$ for the state J = 3 and (3.3 ± 1.4) × 10^{-4} $ev^{-\frac{1}{2}}$ for the state J = 4. The value of the potential scattering length is found to be 4.9 ± 0.5 fm for the state J = 3 and 5.8 ± 0.5 fm for the state J = 4. (auth)

1617 $\bar{\nu}$ OF U^{238} FROM 1.5 TO 15 Mev. I. Asplund-Nilsson, H. Conde, and N. Starfelt (Research Inst. of National Defence, Stockholm). Nucl. Sci. Eng., 20: 527-35 (Dec. 1964).

The average number of prompt neutrons ($\bar{\nu}$) emitted per fission has been measured for the neutron-induced fission of ^{238}U. The measurement was made for several incident neutron energies between 1.5 and 7.5 Mev and for 14.8 Mev. A large liquid scintillator was used as the detector of the fission neutrons. The experimental results can be represented above the threshold for fission by a linear relation $\bar{\nu}(E) = 2.313 + 0.154\,E$. The results with the "universal $\bar{\nu}$-curve." An attempt to investigate the possibility of a step at 6 Mev in the $\bar{\nu}$ versus neutron energy curve was also made. (auth)

1618 THE LOCAL ENERGY APPROXIMATION TO FINITE-RANGE EFFECTS IN DEUTERON STRIPPING REACTIONS. E. V. Ivash (Univ. of Texas, Austin). Phys. Letters, 12: 328-31(Oct. 15, 1964).

A distorted-wave calculation of the effects of finite range in direct reactions, using the so-called local energy approximation based on the optimization of an arbitrary expansion parameter, is considered. The applicability of this method to deuteron stripping reactions is investigated, and the results of the method are compared with those obtained using a method related to the effective-mass approximation. (T.F.H.)

1619 ALPHA PARTICLE EXCITATIONS IN ATOMIC NUCLEI. L. Simons (Univ. of Helsinki). Phys. Letters, 12: 331-4(Oct. 15, 1964).

The alpha-particle excitation model is investigated for even-even nuclei, assuming the time-independent Schroedinger equation to be valid and that no spin-orbit coupling exists. Excited states calculated in this model are compared with experimental values in ^{40}Ca, ^{66}Zn, ^{140}Ce, ^{210}Po, ^{32}S, and ^{142}Ce, as regards spin-parities and energy values. (T.F.H.)

1620 BETA DECAY OF Pr^{144} AND PSEUDOSCALAR COUPLING. H. Daniel, C. Engler, G. Th. Kaschl, and S. A. A. Zaidi (Max-Planck-Institut für Kernphysik, Heidelberg). Phys. Letters, 12: 337-9(Oct. 15, 1964).

The spectral shape and electron polarization are measured for the decay of ^{144}Pr to ^{144}Nd, in order to obtain information of the existence and characteristics of a pseudoscalar coupling contribution to this decay. (T.F.H.)

1621 ON PROTON DECAY OF NUCLEI WITH Z > 50. V. A. Karnaukhov and G. M. Ter-Akopyan (Joint Inst. for Nuclear Research, Dubna, USSR). Phys. Letters, 12: 339-43(Oct. 15, 1964).

The energy systematics of one- and two-proton decay of neutron-deficient nuclei having Z > 50 are studied. Competing alpha-decay processes are taken into account. Regions on the Z–A chart in which proton decay is possible are shown. (T.F.H.)

1622 ON THE POSSIBILITY OF THE MEASUREMENT OF THE NUCLEAR 2^4-POLE DEFORMATION. M. Danos (National Bureau of Standards, Washington, D. C.), W. Greiner, and C. B. Kohr. Phys. Letters, 12: 344-5(Oct. 15, 1964).

The feasibility of a method for measuring the sexadecapole deformation of nuclei is discussed. The major and minor axes of the nucleus are determined by measuring the E1 resonance; the position of the m = 0 and m = 2 components of the E2 resonance are found; and the position of the m = 1 mode is then used to determine the nuclear radius. Using this nuclear radius in a trial function of the form $P_4^{(m)}$ cos θ (cos mϕ), and empirical value of $P_4^{(0)}$ can, in principle, be calculated. An attempt to make this measurement in ^{165}Ho is described. (T.F.H.)

1623 THE ISOBARIC MASS FORMULA FOR A = 17. D. H. Wilkinson (Brookhaven National Lab., Upton, N. Y. and Oxford Univ.). Phys. Letters, 12: 348-9(Oct. 15, 1964). (BNL-8399)

The masses of nuclear quartets having isobaric spins $T = 3/2$ are studied, for the case of A = 17. For $T = 3/2$ quartets the mass formula predicts $M_{-3/2} - M_{+3/2} = 3(M_{-1/2} - M_{+1/2})$, where $M_{-1/2}$ is the mass of the nucleus having $T_z - 3/2$ (T_z of the neutron = $+1/2$), etc. The mass of ^{17}Ne is calculated from the positron-decay lifetime. The experimental value of the left side of the above equation becomes 8.68 ± 0.30 Mev, and that of the right side becomes 8.29 ± 0.01 Mev. Reasons for the difference between these experimental values are discussed. (T.F.H.)

1624 ANGULAR DISTRIBUTIONS OF CONVERSION ELECTRONS FROM ORIENTED Ce^{137m} NUCLEI. R. B. Frankel, D. A. Shirley, and N. J. Stone (Univ. of California, Berkeley). Phys. Rev., 136: B577-83(Nov. 9, 1964). (UCRL-11462)

The angular distributions of K and of (L + M) conversion electrons from oriented ^{137m}Ce nuclei were observed. Precise simultaneous intensity measurements of conversion electrons and γ rays from the same sample provided an accurate, direct determination of the particle parameters b_2 associated with the 255-kev isomeric transition in ^{137}Ce. The K-electron result, $b_2 = 1.061$ (18), is in agreement with a theoretical prediction based on a "point nucleus" model. Techniques and parameters in this experiment are discussed. A determination of the temperature dependence of anisotropy of the 255-kev γ ray yielded the value A = 0.0147 (7) cm^{-1} for the hyperfine structure constant of ^{137m}Ce in neodymium ethylsulfate. This is slightly higher than the value of 0.0129 (12) cm^{-1}, and is to be preferred on the basis of internal evidence. Using the value of $\langle r^{-3}\rangle_{4f} = 4.44$ Au, the derived magnetic moment is changed from 0.96 (09) nm to 0.89 (05) nm. Other radial integrals give different values. A possible discrepancy in the magnetic temperature scale for neodymium ethylsulfate is discussed. (auth)

1625 HYPERFINE STRUCTURE AND NUCLEAR MOMENTS OF Br^{80} AND Br^{80m}. Matthew B. White, Edgar Lipworth, and Seymour Alpert (Univ. of California, Berkeley). Phys. Rev., 136: B584-9(Nov. 9, 1964). (UCRL-11013)

The hyperfine-structure-interaction constants have been measured in the ground states of 18-min ^{80}Br and 4.5 hr ^{80m}Br. The method used was that of atomic-beam radio-frequency spectroscopy with radioactive detection. The magnetic-dipole and electric-quadrupole moments of these isotopes were calculated from the measured interaction constants and nuclear data for the stable Br isotopes. The μI's are corrected for diamagnetic shielding and the Q's are corrected for core polarization effects. (auth)

1626 NUCLEAR CHARGE DISTRIBUTION IN CALCIUM FROM ELECTRON SCATTERING AND MUONIC X RAYS. D. G. Ravenhall (Univ. of Illinois, Urbana), Robert Herman, and B. C. Clark. Phys. Rev., 136: B589-96 (Nov. 9, 1964).

A detailed examination is made of the charge distributions predicted for calcium by experiments with electron scattering and muonic x rays. It is shown that the electron differential cross sections, with both relative and absolute measurements, and the $2p \rightarrow 1s$ x ray energy all predict charge distributions in agreement within experimental error for the three analytic expressions employed. Parameter values for these shapes — Fermi, family II, and modified Gaussian — are given. There is an indication from the electron-scattering relative cross-section analysis, however, that charge distributions with less charge at the extreme edge are favored. (auth)

1627 NUCLEAR TRANSITIONS IN Cs^{133}. E. B. Nieschmidt, C. E. Mandeville, L. D. Ellsworth, and D. D. Bornemeier (Kansas State Univ., Manhattan). Phys. Rev., 136: B597-602(Nov. 9, 1964).

The characteristics of three nuclear transitions in ^{133}Cs have been studied. Observations have been made upon the conversion electrons and/or unconverted quanta emitted in the transitions at 81, 220, and 54 kev. The properties of ^{133}Cs seem not to be fully explained by the single-particle model. (auth)

1628 DECAY OF 20-MINUTE Ag^{115}. E. L. Bahn, Jr. (Washington Univ., St. Louis), B. D. Pate, R. D. Fink, and C. D. Coryell. Phys. Rev., 136: B603-17(Nov. 9, 1964). (MIT-905-17)

A study of radiations from decay of 20-min ^{115}Ag has led to determination of the maximum beta energy as 3.2 ± 0.1 Mev and measurement of intensities of some eighteen γ rays ranging in energy from 0.13 to 2.50 Mev. Measurements via β-γ and γ-γ coincidence spectrometry and via sum-coincidence spectrometry allowed construction of a tentative decay scheme. This scheme uses the ground state and seven excited levels of ^{115}Cd known from studies via the ^{114}Cd(d,p) reaction. It is concluded that the 20-min ^{115}Ag has spin and parity $1/2-$, with about half of the β decays being allowed transitions to states of spins and parities $1/2-$ or $3/2-$ at 2.12 and 2.50 Mev, the remainder being first-forbidden transitions to the ground-state and low-lying $1/2+$ and $3/2+$ levels. No evidence was found for radiations associated with branching to 43-day ^{115}Cd ($11/2-$). (auth)

1629 NUCLEAR LEVELS OF Cd^{115} AND Cd^{117} FROM (d,p) REACTION STUDIES. R. J. Silva and G. E. Gordon (Oak Ridge National Lab., Tenn.). Phys. Rev., 136: B618-24(Nov. 9, 1964). (ORNL-P-41)

Levels of ^{115}Cd and ^{117}Cd below about 3 Mev have been studied by observation of the energy and angular distributions of protons emitted in the ^{114}Cd(d,p) and ^{116}Cd(d,p) reactions respectively. For many of the levels, l values of the captured neutrons have been assigned by comparison of the angular distributions with calculations based on the distorted-wave Born approximation. Results are analyzed in terms of the strong-pairing model of the nucleus. The experimental results are in general agreement with predictions of the model, with the major exception that the energy of the $g_{7/2}$ single-particle orbital is found to be lower than predicted in the cadmium region. The Q values for the (d,p) reactions to the ground states of ^{115}Cd and ^{117}Cd are 3.939 ± 0.020 and 3.550 ± 0.020 Mev respectively. In both cases the ground states have spin and parity $1/2+$. The $11/2-$ isomers lie 173 ± 10 and 133 ± 10 kev above the ground states in ^{115}Cd and ^{117}Cd, respectively. (auth)

1630 HIGH-ENERGY GAMMA RADIATION FROM LITHIUM BOMBARDMENT OF Be^9, B^{10}, B^{11}, AND C^{12}. R. R. Carlson and M. Throop (Iowa State Univ., Iowa City). Phys. Rev., 136: B630-6(Nov. 9, 1964).

Gamma spectra have been obtained with a 5 × 6 in. NaI (Tl) crystal for the bombardment of thick ^{9}Be, ^{10}B, ^{11}B, and ^{12}C targets with ^{6}Li and ^{7}Li beams. Intensities and source assignments are given for all gamma rays observed with an energy of 8 Mev or more. The probable gamma decay of the 9.83-Mev state in ^{15}N was observed for several target-beam combinations. In the ^{6}Li + ^{10}B reaction, the population of the 9.17-Mev state in ^{14}N and the 15.11-Mev state in ^{12}C was observed. The population of these states is forbidden by isotopic-spin selection rules. For each reaction upper-limit total cross sections are about 1 μb for the production of the compound nucleus with subsequent gamma decay. This indicates that compound nuclei are not formed to any significant degree in these reactions. (auth)

1631 OPTICAL-MODEL ANALYSIS OF "QUASIELASTIC" (p,n) REACTIONS. G. R. Satchler, R. M. Drisko, and R. H. Bassel (Oak Ridge National Lab., Tenn.). Phys. Rev., 136: B637-47(Nov. 9, 1964). (ORNL-P-62)

Measured differential cross sections for (p,n) transitions between isobaric analog states are compared with the predictions of an optical model that includes an isobaric spin-dependent potential proportional to $\mathbf{t} \cdot \mathbf{T}_0$, where t and T_0 are the isobaric spins of projectile and target, respectively. The magnitudes of the measured cross sections indicate a strength for this potential that is close to the symmetry potential found from analysis of elastic proton scattering. The shapes of the angular distributions give strong evidence

for the radial shape of this potential to be peaked at the nuclear surface. The calculations are made in the distorted-wave Born approximation using optical potential parameters determined by fits to elastic scattering. Numerical studies are made of the sensitivity of the predictions to various parameter changes to determine the significance of the fits obtained to experiment. Finally, some discussion is given of the "quasi-inelastic" transitions to excited isobaric states in terms of the collective-model description of inelastic scattering. (auth)

1632 PHOTOPRODUCTION OF $\pi^{\pm}$ MESONS IN NITROGEN. G. Piragino (Università, Turin and Istituto Nazionale di Fisica Nucleare, Turin). Phys. Rev., 136: B648-50 (Nov. 9, 1964).

The photodisintegration and $\pi^{\pm}$ photoproduction processes in nitrogen, obtained by exposing a diffusion cloud chamber in a magnetic field to the γ-ray beam of the Frascati synchrotron ($E_{\gamma max}$ = 1000 Mev), are analyzed. The value of the cross section obtained per equivalent quantum and per nucleon for $\pi^{\pm}$ photoproduction is in agreement with that estimated per free nucleon. (auth)

1633 PHOTOPROTONS FROM CARBON. Y. M. Shin and W. E. Stephens (Univ. of Pennsylvania, Philadelphia). Phys. Rev., 136: B660-3(Nov. 9, 1964).

The photoproton cross section of ^{12}C was measured from 20.2 to 22.4 Mev using monochromatic gamma rays from the $^{3}T(p,\gamma)^{4}He$ reaction. The energy of the gamma ray was varied by changing the energy of the incident protons. The gamma rays were monitored by a 3-in.-diam by 4-in.-long sodium iodide crystal. A 2-in.-diam by $\frac{1}{2}$-in.-thick anthracene crystal was used for both the irradiated sample and the proton detector. The protons originating in the anthracene crystal were identified by a pulse-shape discrimination technique. The peak energy of the giant resonance was found to be equal to or greater than 22.4 Mev and the cross section at 22.4 Mev was found to be 13 mb. The cross section curve showed structure at 20.57, 20.95, and 21.38 Mev, with integrated cross sections of approximately 0.3, 0.6, and 1.2 Mev-mb, respectively. The cross section curve also suggested structure in the vicinity of 20 and 22 Mev. The energy dependence of the (γ,p_0) cross section differs from that of the (γ,n) reaction. (auth)

1634 NUCLEAR STRUCTURE STUDIES IN THE CADMIUM ISOTOPES WITH (d,p) AND (d,t) REACTIONS. Baruch Rosner (Univ. of Pittsburgh). Phys. Rev., 136: B664-73(Nov. 9, 1964).

Many new energy levels up to ~2 Mev excitation are located in the odd-A cadmium isotopes. Spins and parities, as well as spectroscopic factors, are determined with the aid of distorted-wave Born approximation (DWBA) calculations. The distinction between the $d_{\frac{5}{2}}$ and $d_{\frac{3}{2}}$ levels was made according to the pickup-to-stripping cross section ratios. The systematic behavior of the first excited state for the various spin values enables us to conclude that the first excited states in ^{115}Cd and ^{117}Cd are $d_{\frac{3}{2}}$ states and the 300-kev state in ^{113}Cd is an unresolved $d_{\frac{5}{2}}$-$d_{\frac{3}{2}}$ doublet. The (d,p) spectra for reactions leading to odd cadmium isotopes that differ from each other by as much as four neutron pairs, and to Cd–Pd isotones that differ by one proton pair, are compared. The changes in the observed spectra, as well as in the location of the neutron single-particle states, are rather small in both cases. The various approximations for the evaluation of the pairing-theory parameters, such as the occupation numbers and the single-quasiparticle energies, from the experimental data are discussed. The need for good DWBA calculations for the (d,t) reactions in order to avoid the necessity of renormalizations, and for cross checking of the results, is stressed. The effect of the quadrupole interaction on the single quasiparticles is clearly seen in cadmium from the fact that the $s_{\frac{1}{2}}$ state becomes the ground state in ^{111}Cd even though its occupation number is as low as $V^2_{\frac{1}{2}} = 0.1$. (auth)

1635 RADIATIVE TAIL FOR INELASTIC ELECTRON SCATTERING. L. C. Maximon and D. B. Isabelle (National Bureau of Standards, Washington, D. C.). Phys. Rev., 136: B674-83(Nov. 9, 1964).

The cross section differential in the energies and angles of all final particles for the bremsstrahlung that accompanies nuclear excitation is derived, in first Born approximation and neglecting nuclear recoil, in terms of the form factors corresponding to the coulomb and current interactions, which are left arbitrary throughout the calculation. This cross section is integrated over all photon angles, without approximation, and its limit for large energies ($E \gg mc^2$) of the initial and final electron is discussed. As in the case of elastic electron scattering, photons emitted in the direction of either the incoming or outgoing electron contribute to this integrated cross section terms of order $\ln(E/mc^2)$, while all other photon directions contribute terms of relative order 1. Explicit expressions for these terms are given, as well as a numerical evaluation for some typical cases; the formulas are also valid for electron scattering angles ϑ equal or very close to 180°. It is shown explicitly that the logarithmically divergent terms that appear in the integral of high-energy cross section over the energy of the final electron are cancelled exactly, if to this integral one adds the radiative corrections to the inelastic electron scattering cross section. (auth)

1636 RESONANCE NEUTRON CAPTURE AND TRANSMISSION IN SULFUR, IRON, AND LEAD. R. L. Macklin, P. J. Pasma, and J. H. Gibbons (Oak Ridge National Lab., Tenn.). Phys. Rev., 136: B695-703(Nov. 9, 1964). (ORNL-P-98)

Resonances in both the capture and total cross sections for ^{32}S, ^{56}Fe, ^{206}Pb, ^{207}Pb, and ^{208}Pb were investigated from 10 to 80 kev. Total and radiative widths, and in some cases spins and/or parities, were assigned, and isotopic identifications of resonances were made. Resonances, mostly due to $l > 0$ neutrons, were found in all of these nuclei. The p-wave level density for ^{206}Pb and ^{207}Pb was found to be more than twice as high as one would expect from the number of observed s resonances. The total radiative widths for an $l_n = 0$ versus two $l_n = 1$ resonances for ^{207}Pb targets differed by a factor of 10. The effective nuclear radius, R′, was found to be $(8.5 \pm 0.2)f(^{206}Pb)$, $(9.5 \pm 0.3)f(^{207}Pb)$, and $(8.4 \pm 0.3)f$ (^{208}Pb), giving an average of $(8.8 \pm 0.3)f$ which is in agreement with an optical-model prediction of 8.7f. (auth)

1637 NEUTRON RESONANCES OF SELENIUM. R. E. Cote, L. M. Bollinger, and G. E. Thomas (Argonne National Lab., Ill.). Phys. Rev., 136: B703-10(Nov. 9, 1964).

The neutron resonances of selenium have been studied by a wide variety of methods over the energy range from a few electron volts to several kev. The measured values of the total cross section are presented from 100 ev to about 5 kev. Information from transmission measurements on enriched samples and from capture gamma spectra are used to make isotopic assignments of resonances. The capture gamma data are also used for spin assignments. Complete sets of parameters are determined for most of the many resonances below 2 kev assigned to ^{77}Se and for the resonances below 5.5 kev assigned to the even-even targets. Average values of spacings and strength functions are deduced. The strength functions for ^{76}Se and ^{77}Se are $(1.6^{+1.3}_{-0.7}) \times 10^{-4}$ and $(1.7^{+1.3}_{-0.7}) \times 10^{-4}$, respectively. These relatively large values reinforce the observation of an intermediate structure in the dependence of strength function on nuclear size, an effect that has been interpreted as evidence for the influence of two-particle one-hole states. The question of a possible spin dependence of the strength function is discussed. (auth)

1638 COHERENT SCATTERING OF SLOW NEUTRONS BY A LIQUID. K. S. Singwi (Argonne National Lab., Ill.). Phys. Rev., 136: A969-80(Nov. 16, 1964).

The convolution approximation of Vineyard to treat the coherent scattering of slow neutrons by a monatomic liquid is extended. The correction term, which takes care of correlations between neighboring atoms, is evaluated on the basis of a quasicrystalline model of a liquid. In the calculation proper account is, however, taken of the geometrical arrangement and dynamical behavior of atoms in a liquid. Expression for the width of the quasielastic scattering is derived which exhibits a characteristic os-

cillatory behavior as a function of momentum transfer. Explicit numerical calculations for the width were made for liquid argon near the triple point, which are in reasonably good agreement with experiment. An interesting feature of the basic formula is the temperature dependence of the width for a given momentum transfer, which is also in qualitative agreement with experiment. There are other features which need to be tested by further experiments, suggestions for which were outlined. (auth)

1639 SCATTERING OF SLOW NEUTRONS BY DEUTERATED METHANE. George W. Griffing (Phillips Petroleum Co., Idaho Falls, Idaho). Phys. Rev., 136: A988-91(Nov. 16, 1964).

The scattering of slow neutrons by gaseous deuterated methane was computed. This case is of particular interest since contributions to the scattering from the direct scattering terms and the interference scattering terms can be comparable in magnitude. Plausible arguments are presented which suggest that an incident neutron energy of 0.1 ev is large enough so that experimental results on liquid CD_4 using neutrons of that energy could be confidently compared with the calculated results for a gas, without the difficulties caused by liquid effects in interpreting the scattering at smaller incident-neutron energies. (auth)

1640 CROSS SECTIONS FOR THE REACTIONS $^{206}Pb(n,n')^{206m}Pb$ AND $^{206}Pb(n,3n)^{204m}Pb$. I. Heertje, L. Delvenne, and A. H. W. Aten, Jr. (Instituut voor Kernphysisch Onderzoek, Amsterdam). Physica, 30: 1609-11 (Aug. 1964).

Cross section curves are suggested for the reactions $^{206}Pb(n,n')^{206m}Pb$ and $^{206}Pb(n,3n)^{204m}Pb$, based on activation with neutrons of different energy distributions. (auth)

1641 NEUTRON TOTAL CROSS SECTION OF BENZENE AND DIPHENYL BETWEEN 0.1 AND 0.001 ev. B. Antonini and A. Paoletti (C.S.N., Casaccia, Italy and C.N.E.N., Rome). Physica, 30: 1647-54(Aug. 1964).

The total neutron cross section of hydrogen bound in benzene and diphenyl was determined with the time of flight method in the energy range 0.1–0.001 ev. The experimental results are compared with theoretical curves calculated for benzene and show some evidence of hindrance of rotation in diphenyl compared to benzene. (auth)

1642 REGULARITY IN ENHANCEMENT PHENOMENON OF ALLOWED BETA-TRANSITIONS TO EVEN-EVEN NUCLEI. S. M. Brahmavar, A. S. Venkatesha Murthy, and M. K. Ramaswamy (Karnatak Univ., Dharwar, India). Proc. Indian Acad. Sci., Sect. A, 60: 134-7 (Aug. 1964).

Recent attempts to understand the beta-decay process based on log ft values are mentioned. An up-to-date analysis of all allowed beta-transitions gives quite a few nuclei that show enhancement. Further study of these enhancements revealed a systematic trend in excitation energy, decay process, and the existence of these even-even nuclei. (auth)

1643 EFFECT OF CONFIGURATION MIXING ON M4 TRANSITIONS. Hisashi Horie and Takeshi Oda (Tokyo Inst. of Tech.). Progr. Theoret. Phys. (Kyoto), 32: 65-73(July 1964).

The reduced matrix elements of M4 transitions in ^{87}Sr, ^{89}Y, ^{207}Pb and N = 81 nuclei were calculated from the standpoint of the configuration mixing. The calculations are based upon simple perturbation theory, and the parameters used are the same as those adopted for magnetic and quadrupole moments and $\underline{1}$-forbidden M1 transitions in the previous calculations. The experimental reduced matrix elements are explained fairly well by small admixtures of excited configurations to the single-particle shell model wave functions. (auth)

1644 EFFECTS OF NUCLEAR CORRELATION ON DIRECT NUCLEAR REACTIONS. Il-Tong Cheon (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto), 32: 74-87(July 1964).

The effects of nucleon correlations near the nuclear surface on the differential cross sections for direct reactions of the forms (p,p') and (α,α') are investigated on the basis of the Butler theory. (D.C.W.)

1645 AN EXTENDED BOSON APPROXIMATION IN THE THEORY OF NUCLEAR STRUCTURE. Ken-ji Hara (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto), 32: 88-105 (July 1964).

The conventional Boson approximation is extended to include the effect of the Pauli principle explicitly. The quasi-particle distribution at the boson ground state is calculated. (D.C.W.)

1646 A NOTE ON THE OHMURA METHOD OF POTENTIAL DEDUCTION. William A. Pearce (Rice Univ., Houston, Tex.). Progr. Theoret. Phys. (Kyoto), 32: 180-1 (July 1964).

The practicality of a previously presented variational method for finding phase-shift-equivalent nuclear potentials was investigated by re-examining the originally considered case in which n-p scattering is exactly described by a shape-independent formula. (D.C.W.)

1647 NUCLEAR INTERACTION OF CORE REGION. Shoichiro Otsuki (Nagoya Univ., Japan), Ryozo Tamagaki, and Masanobu Wada. Progr. Theoret. Phys. (Kyoto), 32: 220-41(Aug. 1964).

The singlet S phase shift $^1\delta_0$ is calculated by assuming a nuclear potential with a soft core of the Yukawa shape, Gaussian shape, or modified Gaussian shape $\exp\{-(\kappa x)^4\}$ surrounded by an attractive well with the one-pion-exchange tail. It is shown that short-tailed soft cores, such as the Gaussian or the modified-Gaussian shape, can explain the behavior of $^1\delta_0$ up to 1 Gev, while the long-tailed core, such as the Yukawa shape with range >1/M, cannot reproduce $^1\delta_0$ even in the energy region 0 ~ 200 Mev. It is argued that the explanation of the origin of the soft core in terms of a vector-meson-exchange is rather unprobable. The effective radius of the soft core is found to be 0.4 to 0.5/μ and the effective height a few Gev. It is pointed out that the nuclear interaction may have a different nature outside and inside the effective core radius. The energy dependence of the absorption coefficient is found as a function of the impact parameter. The strong repulsion at low energies and the strong absorption at tens Bev, which are characteristic of the inner part, could be regarded as a manifestation of degrees of freedom inherent in the core region. Importance of the nucleon-nucleon polarization measurement in the Bev energy region, as well as the measurement of the four-momentum transfer in the cosmic ray nuclear interactions, is discussed in order to clarify the core region interaction. A hypothetical interpretation on the substantial carrier of the degrees of freedom is proposed based on an analogy with nucleus that the carrier is a many-body-system of ur-fermions. The core is interpreted as the exchange repulsion due to the antisymmetrization among the ur-fermions. (auth)

1648 THE DETERMINATION OF THE YIELDS OF SEVERAL FRAGMENTS IN THE FISSION OF HEAVY NUCLEI BY MULTIPLY-CHARGED IONS. II. THE FISSION OF ^{238}U BY IONS OF ^{22}Ne. I. Brandshtetr, I. Zvara, T. Zvarova, V. Knoblokh, M. Krzhivanek, Ya. Maly, and Hung-kuei Su. Radiokhimiya, 6: 479-84(1964). (In Russian)

The yields of a number of fission products in the fission of ^{238}U by quadruply charged ions of ^{22}Ne were investigated. The irradiations were carried out in the cyclotron of the Joint Institute for Nuclear Investigations with neon ions of 145 to 150 Mev. The yield measurements were carried out by radiochemical separations of the various radioisotopes. In the reaction with ^{22}Ne, ^{238}U forms the compound nucleus $^{260}102$. This nucleus appeared to have the greatest probability for fission accompanied by the emission of approximately twelve neutrons. In contrast with the fission of ^{238}U with neutrons, the yield curve for ^{238}U by ^{22}Ne showed only a single peak at about mass number 124. Also, there was a high probability for the formation of stable isotopes directly in fission or even the for-

mation of neutron-deficient isotopes. Approximately 49 isotopes were identified and quantitatively measured ranging from mass number 72 to 179. In the Tm fraction a β^--emitter with a period of 7.8 ± 0.5 hr was identified. It also had a γ-radiation of 0.40 ± 0.02 Mev and possibly one of 0.48 Mev. From the yield, it was tentatively assigned to ^{173}Tm. From the curve presented, the mean fission cross section calculated for the energy region 150 to 105 Mev was approximately 2 barns. (TTT)

1649 STUDIES ON PROTON STRUCTURE USING DIFFERENTIAL COLLISION SECTIONS FOR THE INDIVIDUAL PHOTOPRODUCTION OF π^0 MESONS AND FOR COMPTON EFFECT. G. Cortellessa, A. Reale, and P. Salvadori (Istituto Superiore di Sanita, Rome). Rend. Ist. Super. Sanita, 23: 1177-97(1960). (In Italian)

Nuclear structure as revealed in processes involving π mesons is briefly reviewed, and experimental results obtained in this field are presented and discussed. The Compton effect is then discussed, and results from measurements on this process are given. (H.M.G.)

1650 GREEN FUNCTIONS IN LOW-ENERGY NUCLEAR PHYSICS. D. J. Thouless (Cambridge Univ., Eng.). Rept. Progr. Phys., 27: 53-91(1964).

The response of a system in its ground state to an external perturbation can be described in terms of Green functions. The formal properties of such Green functions are described, and methods of calculating them are given. It is shown how such methods have been applied to various problems in nuclear physics, and some further possible applications are indicated. The theory of nuclear matter, the foundations of the optical model, and the theory of nuclear collective motion are considered; and it is shown how the methods can be modified to allow for the influence of pairing forces by techniques borrowed from the theory of superconductivity. 100 references. (auth)

1651 OVERLAP INTEGRAL FOR REACTIONS WITH DEUTERONS. O. Dumitrescu (Univ. of Bucharest) and A. Săndulescu. Rev. Roumaine Phys., 9: 531-9(1964).

Explicit expressions for the overlap integrals occurring in the reactions with deuterons were obtained. For the individual nucleons are used harmonic oscillator wave functions and for the deuteron—a pure S-state wave function, obtained as a solution of the Schrödinger equation for various potentials (square well, Yukawa, and Hulthén potential). (auth)

1652 HYDRODYNAMIC THEORY OF MULTIPLE PARTICLE PRODUCTION IN FAST NUCLEON COLLISIONS WITH NUCLEI. G. A. Milekhin. Trudy Fiz. Inst., Akad. Nauk SSSR, 16: 50-93(1961). (In Russian)

The basic experimental and theoretical concepts of high-energy particle collisions are reviewed, and problems of relativistic hydrodynamics are analyzed. The number of particles produced as functions of primary particle energy and nuclear weight was found on the basis of the hydrodynamic model. Energy and transverse momentum distributions for secondary particles were investigated. Correlations of theoretical and experimental data indicate that the multiple production of particles is well described by hydrodynamic theory. (R.V.J.)

1653 DETERMINATION OF AVERAGE β ENERGY PER FISSION OF URANIUM-235 USING THERMOLUMINESCENCE DOSIMETRY. Norbert Haering (Technische Hochschule, Munich). Z. Naturforsch., 19a: 978-90(July-Aug. 1964). (In German)

The mean β energy per fission of ^{235}U is given as 8.6 Mev ± 4%. The total β energy emitted from the fission products of a uranium foil was absorbed in a calcium fluoride sphere (powder). As measurement for the absorbed energy the proportional thermoluminescence intensity of the calcium fluoride was used. The relative classification of both these magnitudes was obtained with the help of an absolute calibrated ^{32}P preparation. Similar geometry, the same research conditions as far as possible in the calibrated sample, and numerous individual measurements of the thermoluminescence yield reproducible values. The contribution of various γ intensities to the absorbed energy is considered. (tr-auth)

1654 PROJECT FOR THE MEASUREMENT OF THE TOTAL EFFECTIVE CROSS-SECTION IN THE INTERACTION OF NEUTRONS HAVING AN ENERGY OF 14 Mev WITH CERTAIN LIGHT ELEMENTS. Ryszard Braun and Leszek Kasinski. Zeszyty Nauk. Univ. Lodz., Ser. II, No. 9, 5-22(1961).

A deuteron accelerator designed mainly to produce fast neutrons from a tritium target is briefly described, and the preliminary results of measurements of the total effective neutron cross sections of light elements are reviewed. The total effective cross section is calculated; the errors are discussed. (D.C.W.)

1655 UNIFIED THEORY OF NUCLEAR MODELS. G. E. Brown. New York, John Wiley and Sons, Inc., 1964. 184p. $7.25.

A unified theoretical treatment is given of the shell, collective, and optical models. The topics reviewed include occupation number representations, self-consistent fields, rotations, pairing, and quasiparticles. (T.F.H.)

1656 THE NUCLEAR PROPERTIES OF THE HEAVY ELEMENTS. I. SYSTEMATICS OF NUCLEAR STRUCTURE AND RADIOACTIVITY. Earl K. Hyde, Isadore Perlman, and Glenn T. Seaborg. Prentice-Hall International Series in Chemistry. Englewood Cliffs, N. J., Prentice-Hall, Inc., 1964. 439p. $15.00.

The general features of nuclear instability and radioactivity for the elements from lead through lawrencium are treated. Mass equations and experimental trends in the total decay energy for alpha and beta decay are presented, including a complete table of atomic masses and associated quantities. The independent-particle and unified models are reviewed, stressing their suitability for correlating decay data. Theory for alpha decay is also considered, and experimental data for the alpha emitters are tabulated. Methods for synthesizing the heavy nuclei are discussed; cross sections for charged particle and neutron reactions are tabulated. (D.C.W.)

1657 STRONG INTERACTION PHYSICS. A LECTURE NOTE VOLUME. AN INTRODUCTION TO THE ANALYSIS OF STRONG-INTERACTION PROCESSES. Maurice Jacob. NUCLEAR DEMOCRACY AND BOOTSTRAP DYNAMICS. Geoffrey F. Chew. New York, W. A. Benjamin, Inc., 1964. 165p. $9.00(cloth edition); $4.95 (paperback).

The analysis of strong interactions is reviewed, with attention to kinematics, partial-wave amplitudes, charge independence, the phenomenology of pion—nucleon scattering, new mesons, dispersion-relation analysis of pion—nucleon scattering, nearby singularities, and the peripheral model. Bootstrap dynamics for nuclear reactions are reviewed, with attention devoted to maximal analyticity of the first and second degrees, nonrelativistic models, and relativistic bootstrap dynamics. (T.F.H.)

1658 L'EFFET MÖSSBAUER ET SES APPLICATIONS A L'ETUDE DES CHAMPS INTERNES. (The Mössbauer Effect and Its Applications in the Study of Internal Fields). A. Abragam. Documents on Modern Physics. New York, Gordon and Breach Science Publishers, 1964. 70p. $1.95 (Paper); $3.95(Cloth).

The Moessbauer effect and the theoretical explanation of its occurrence are described. The effect of ultrasonics on the Moessbauer effect is explored in quantum and classical treatments, which lead to different predictions. The Moessbauer effect in ^{57}Fe and ^{119}Sn is then described. (J.S.R.)

1659 THE NUCLEAR PROPERTIES OF THE HEAVY ELEMENTS. II. DETAILED RADIOACTIVITY PROPERTIES. Earl K. Hyde, Isadore Perlman, and Glenn T. Seaborg. Prentice-Hall International Series in Chemistry. Englewood Cliffs, N.J., Prentice-Hall, Inc., 1964. 714p. $25.00.

The natural radioactivity of the elements from lead through lawrencium is discussed. The topics include the natural radioactivity of the heavy elements, artificially prepared families of radioactive nuclides, the isotopes of thorium, protactinium, and uranium, the transuranium elements, and nuclei near lead-208. (C.E.S.)

1660 THE NUCLEAR PROPERTIES OF THE HEAVY ELEMENTS. III. FISSION PHENOMENA. Earl K. Hyde. Prentice-Hall International Series in Chemistry. Englewood Cliffs, N. J., Prentice-Hall, Inc., 1964. 560p. $18.00.

Fission phenomena of the elements from lead through lawrencium are discussed. The topics include an account of the discovery of fission, fission theory, the probability of fission, distribution of mass in fission, distribution of nuclear charge in fission, kinetic energy of fission fragments, prompt neutrons emitted in fission, delayed neutrons in fission, prompt gamma rays in fission, fission phenomena at moderate excitation energy, nuclear reaction phenomena including fission at high bombardment energy, fission induced by mesons, and photofission. (C.E.S.)

1661 A MEASUREMENT OF μ^- TOTAL CAPTURE RATE IN He^4. R. Bizzarri, E. di Capua, U. Dore, G. Gialanella, P. Guidoni, and I. Laakso (Università, Rome and Istituto Nazionale di Fisica Nucleare, Rome). p.21-3 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

The total capture rate of μ^- mesons in ^4He was measured by exposing the Rome University liquid He bubble chamber to the CERN slow μ^- beam. Scanning of the pictures gave 123,000 decays and 304 non-decaying stopping tracks. After subtraction of π^- background, a capture rate of $340 \pm 65\ s^{-1}$ was obtained. Studies of proton background still in progress may result in a small correction. (A.G.W.)

1662 EXPERIMENTAL CAPTURE RATE FOR MUONS IN He^4. M. M. Block (Northwestern Univ., Evanston, Ill.). T. Kikuchi, D. Joetke, M. Schneeberger, C. R. Sun, R. Walker, G. Culligan, V. L. Telegdi, and R. Winston. p.26-9 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

A muon beam obtained by converting the internal 400-Mev proton beam of the Chicago cyclotron to π^- in a Be target was directed into a liquid He bubble chamber. Scanning of the film showed 136×10^3 μ^- decays and 108 captures in the ^4He. The capture rate obtained was $364 \pm 46\ sec^{-1}$. This result is consistent with other experiments within quoted errors. (A.G.W.)

1663 LIFETIME OF $_\Lambda H^3$. M. M. Block (Northwestern Univ., Evanston, Ill.), R. Gessaroli, S. Ratti, M Schneeberger, L. Grimellini, T. Kikuchi, L. Lendinara, L. Monari, W. Becker, and E. Harth. p.62-3 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

The lifetime of $_\Lambda H^3$'s found in the He bubble chamber in the absorption reaction $K^- + {}^4He \rightarrow {}_\Lambda H^3 + \pi^- + p$ was measured. On the basis of 39 events, of which 33 decayed in flight, a lifetime of $(0.95^{+0.15}_{-0.12}) \times 10^{-10}$ sec was found by a maximum likelihood method. When only the 33 decays in flight were used, a value of $(0.70^{+0.18}_{-0.13}) \times 10^{-10}$ sec was obtained. These results are considerably different from the theoretical estimate predicted by Dalitz. (A.G.W.)

1664 REPORT ON THE PRODUCTION OF Li^8 FRAGMENTS FROM THE INTERACTIONS OF 1.3 AND 1.5 Gev/c K^- MESONS WITH EMULSION NUCLEI. p.323-8 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

Final results are reported from a study of the production of ^8Li fragments from the interaction of 1.3 and 1.5 Bev/c K^- mesons with emulsion nuclei. The frequency of emission of ^8Li fragments in stars with $N_h > 8$ was found to be $(1.27 \pm 0.20)\%$ and $(1.21 \pm 0.18)\%$ respectively for the two K^- momenta. Angular and energy distributions of the ^8Li fragments are shown in figures. No significant difference was seen between the two momenta. There is some evidence that a K^-meson transfers a very large forward momentum (about 1 Bev/c) to a heavy nucleus in the interactions. (A.G.W.)

1665 HEAVY HYPERFRAGMENTS PRODUCED IN NUCLEAR EMULSION BY THE INTERACTIONS OF K^- MESONS OF MOMENTA 800, 1500 AND 3500 Mev/c. A. W. Key (Nuclear Physics Lab., Oxford). p. 328-32 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

Preliminary results from a study of about 1800 double star events produced by K^- mesons of momenta 800, 1500, and 3500 Mev/c in nuclear emulsions are presented. The experimentally measured parameters for the primary and secondary stars of the double star events at each of the three energies are tabulated. The percentage production of the heavy hyperfragments seems to decrease with increasing K^- momentum. The vaues of the average number of black and gray tracks emitted from the primary star suggest that these events are predominantly produced by interactions on the heavy emulsion nuclei. The percentage of double star events with more than one light track from the primary star and the forward to backward ratio of these light tracks increase sharply with energy. Values of the velocity imparted to the target nucleus in the cascade stage and the average momentum of an evaporated particle are calculated. The results are compared to the predictions of the nuclear recoil model. (A.G.W.)

1666 STUDY OF HYPERFRAGMENTS FROM THE INTERACTIONS OF 800 Mev/c K^- MESONS. I. Ahmed and M. A. Shaukat (Atomic Energy Centre, Lahore, Pakistan). p.333-6 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

A stack of 72 Ilford K-5 emulsion pellicles was exposed to a separated team of 800-Mev/c K^- mesons from the Berkeley Bevatron. From 500 interactions of the beam particles, 295 hyperfragments were identified, a production rate of $6.5 \pm 0.4\%$ after corrections. The range distribution of the hyperfragments, the total prong distribution from the two centers, the distribution of the visible energy release in non-mesonic hyperfragments, and the energy spectrum of the fast protons from the hyperfragment decays are shown in figures. The average number of prongs is about 8, and therefore charge of the interacting nucleus is greater than 8. Evidence is presented that the masses of the short hyperfragments are greater than 20 mass units. Probably some are spallation fragments in which the Λ hyperon is trapped and a separate star distinct from the original K^- interaction is formed. The upper limit of Λ binding energy appears to be about 25 Mev. (A.G.W.)

1667 PRODUCTION OF HYPERFRAGMANTS BY 1.5 Gev/c K^- MESONS. J. Cuevas, J. Diaz, D. M. Harmsen, W. Just, E. Lohrmann, H. Spitzer, and M. W. Teucher (Institut fur Experimentalphysik and Deutsches Elektronen-Synchrotron DESY, Hamburg). p.337-40 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

A stack of 120 pellicles of Ilford G-5 emulsions was exposed to a separated beam of K^- mesons at CERN. In about 38700 interactions, 1200 gave rise to hyperfragments, a visible production rate of 3.1%. An attempt was made to separate the hyperfragments into two groups according to the charge of the target nucleus (AgBr or CNO). Corrections were made for beam contamination and for events overlooked for various reasons. The total production rate, the ratio of hyperfragments produced to the number of K^- stars, was found to be 7%. About 5% of the hyperfragments were produced on CNO target nuclei and about 95% on AgBr. The probability of producing a hyperfragment on a CNO nucleus is 1–2%; for a AgBr nucleus it is about 9%. About 1% of the total number of visible hyperfragments were found to satisfy criteria for production by fission. (A.G.W.)

1668 HEAVY HYPERFRAGMENTS PRODUCED IN THE INTERACTIONS OF 25 Gev PROTONS, 17.2 Gev/c π^--MESONS, AND 1.5 Gev/c K^--MESONS WITH NUCLEI OF IONOGRAPHIC EMULSIONS. G. Baumann, H. Braum, and P. Cueer (Centre de Recherches Nucleaires, Strasbourg). p.341-4 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963. (In French)

Stacks of Ilford G5 emulsion were exposed to beams of 25-Bev protons, 17.2-Bev/c mesons (π^-), and 1.5-Bev/c mesons (K^-). The mean mass, mean charge, mean-free-path distribution, and recoil distribution of the hyperfragments were obtained, together with the upper limit of the bonding energy of the hyperfragments. (D.C.W.)

1669 PHOTOPRODUCTION OF NEGATIVE AND POSITIVE PIONS FROM CARBON AT FORWARD ANGLES. W. A. Blampied, J. S. Greenberg, V. W. Hughes, D. C. Lu, and R. C. Minehart (Yale Univ., New Haven). p.472-7 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

Preliminary results are reported from measurements performed on the photoproduction of positive and negative pions on carbon using the nominally 3-, 4-, and 5-Bev bremsstrahlung beams from the Cambridge electron accelerator. Experimental cross sections at a laboratory production angle of $2.70^{+0.15}_{-0.05}$ are shown and compared with theoretical predictions by Drell. Positron rates were measured simultaneously with the pion rates at each chosen momentum. It is concluded that pion production rates at forward angles are predicted by the one-pion exchange model used by Drell to within approximately a factor of two. (A.G.W.)

1670 PRIMAKOFF EFFECT AND π^0 LIFETIME. G. Bellettini, C. Bemporad, P. L. Braccini, and L. Foa. p.507-11 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

An experiment was designed to detect the coherent electromagnetic production of π^0 in the process γ + nucleus → π^0 + nucleus at 1 Bev in the hope of distinguishing the contribution of the Primakoff effect from the coherent nuclear production and from the incoherent production. The apparatus used for detection of pions produced in a lead target is described. In spite of large statistical errors, the angular distributions obtained are considered to give definite experimental evidence of the Primakoff peak. A rough and very preliminary three parameters fit to the experimental distributions was attempted by hand calculation for angles smaller than 4 degrees. (A.G.W.)

1671 DEUTERON STRIPPING AT 3.54 Gev/c. R. L. Lander, O. Piccioni, Nguyen hun Xuong, and P. M. Yager (Univ. of California, San Diego, La Jolla). p.651-3 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

Protons stripped from deuterons at 3.54 Bev/c by Al, Cu, and Pb were observed in the BNL 20-in. hydrogen bubble chamber. Angular and momentum distributions are shown for two methods of event selection. It is noted that about 1% of the incident deuterons are converted to protons (of 1.77 ± 0.100 Bev/c) within a solid angle of 10^{-4} steradians at zero degrees. (A.G.W.)

1672 SOME RESULTS ON INTERACTIONS OF HIGH ENERGY PARTICLES WITH HEAVY NUCLEI. L. Hoffmann (CERN, Geneva), N. K. Rao, M. A. Shaukat, et al. p.654-8 of "Proceedings of the Sienna International Conference on Elementary Particles. Vol. I." Bologna, Societa Italiana di Fisica, 1963.

The technique of nuclear emulsions exposed in a strong magnetic field was applied to analysis of fast secondaries from high-energy proton (24 Bev/c) and pion (17 Bev/c) interactions with heavy emulsion nuclei (Ag and Br) accompanied with high excitation of the target nucleus. The excess of positive particles among fast secondaries was was 2.3 ± 0.5 per interaction for protons and 1.0 ± 0.4 per interaction for pions. The momentum spectra of fast secondaries for both particles are shown; they are rather similar. No group of particles clearly distinguished by their energy, emission angle, and sign of charge was discovered. The transverse momentum (pt) distribution for both proton and pion experiments are shown. The secondary protons have higher pt values than pion secondaries. A clear difference between the behavior of all the above characteristics for the interactions with relatively weaker and stronger nuclear excitation was observed in both proton and pion experiments. (A.G.W.)

1673 PHYSIQUE NUCLEAIRE DES BASSES ENERGIES. COLLOQUE I. I. S. N., BRUXELLES 1962. (Low-Energy Nuclear Physics. Institut Interuniversitaire des Science Nucleaires Colloquim, Brussels, [Sept. 17-22], 1962). Louvain, Belg., Librairie L. Wouters, 1962. 385p.

The twenty-seven papers presented at the Colloquim on low-energy nuclear physics in Brussels are compiled. Individual abstracts were prepared for twenty-four papers. Three abstracts previously appeared in NSA (16: 26330 and 17: 26544 and 38105). (J.S.R.)

For abstracts of individual papers see: 1308, 1674, 1675, 1676, 1677, 1678, 1679, 1680, 1681, 1682, 1683, 1684, 1685, 1686, 1687, 1688, 1689, 1690, 1691, 1692, 1693, 1694, 1695, and 1696.

1674 PROPERTIES OF THE EXCITED STATES OF EVEN-EVEN SPHERICAL NUCLEI. R. A. Ricci (Istituto Nazionale di Fisica Nucleare, Naples and Università, Naples). p.1-42 of "Physique Nucleaire des Basses Energies." Louvain, Belg., Librairie L. Wouters, 1962. (In French)

The data available on the properties of the excited states of even-even spherical nuclei are reviewed. The discussion is systematized by a division into nuclei with characteristic levels of j-j coupling, vibrational nuclei, and nuclei with quasi-particle levels. The E2 transitions to 2^+ states are also considered. (J.S.R.)

1675 RESONANCE SCATTERING OF GAMMA RAYS. V. J. Vanhuyse. p.51-67 of "Physique Nucleaire des Basses Energies." Louvain, Belg., Librairie L. Wouters, 1962.

Factors to be considered in the experimental measurement of the resonance scattering of γ rays are reviewed. The methods used in the measurement of short lifetimes are indicated. The expressions for resonance absorption cross sections are given. Methods used to obtain highly monoenergetic γ-ray sources of variable energy are described, and the use of bremsstrahlung as a photon source is discussed. The effect of scalar and tensor polarizability on the cross sections for resonance absorption is considered. (J.S.R.)

1676 DISCUSSION OF THE ARRANGEMENT OF EXPERIMENTAL VALUES FOR THE PROBABILITY OF E1 NUCLEAR TRANSITION. C. F. Perdrisat (Ecole Polytechnique Fédérale, Zurich). p.68-80 of "Physique Nucleaire des Basses Energies." Louvain, Belg., Librairie L. Wouters, 1962. (In French)

The experimental results on the probability of E1 transitions are reviewed for odd and even A, spherical and deformed nuclei. 26 references. (J.S.R.)

1677 ALPHA PARTICLE CAPTURE. P. M. Endt. p.81-96 of "Physique Nucleaire des Basses Energies." Louvain, Belg., Librairie L. Wouters, 1962. (In French)

Reactions (α,γ) on ^{20}Ne, ^{22}Mg, ^{28}Si, ^{30}Si, ^{32}S, and ^{34}S were studied at α energies up to 3.2 Mev. The interpretation of the angular distributions and correlations of the γ radiation is discussed. The resonances found are graphed. (J.S.R.)

1678 THE REACTION ^{30}Si(p,γ)^{31}P. H. Van Rinsvelt. p.97-104 of "Physique Nucleaire des Basses Energies." Louvain, Belg., Librairie L. Wouters, 1962. (In French)

The ^{30}Si(p,γ)^{31}P reactions were studied to obtain data on the excited levels of ^{31}P. The resonance curves obtained at E_γ = 1.5 to 10.5 Mev are given. The energy, spin, and angu-

lar correlations of the resonances found are tabulated. The characteristics of the (1481.1 – 1482.6)-kev doublet are established. (J.S.R.)

1679 EFFECTS OF ANGULAR MOMENTUM IN FISSION. M. Nève de Mévergnies (CEN, Mol, Belg.). p.105-26 of "Physique Nucleaire des Basses Energies." Louvain, Belg., Librairie L. Wouters, 1962. (In French)

The theoretical and experimental studies undertaken to verify the consequences of the Bohr hypothesis on the relation between the liquid drop and unified models are reviewed. The success of the Bohr model in interpreting the angular distribution of fission fragments and fission by slow neutrons is discussed. (J.S.R.)

1680 POLARIZED β-γ CORRELATION IN ^{41}Ar AND ^{46}Sc. Marc Chabre (Université, Grenoble, France). p.127-34 of "Physique Nucleaire des Basses Energies." Louvain, Belg., Librairie L. Wouters, 1962. (In French)

The polarized β-γ correlation was studied in two mixed permitted transitions characterized by $\Delta J = 0$ with no change of parity. The method of forward Compton scattering was used to measure the correlation coefficient A for ^{41}Ar and ^{46}Sc. For ^{41}Ar, A = 0.09 ± 0.04 with y = 0.01 ± 0.05 and for ^{46}Sc A = 0.12 ± 0.02. (J.S.R.)

1681 DECAY SCHEME OF Ir^{192}. J. Kern. p.141-7 of "Physique Nucleaire des Basses Energies." Louvain, Belg., Librairie L. Wouters, 1962. (In French)

The results of the preliminary measurement of the decay of ^{192}Ir are reported. The interpretation of the energy levels of ^{192}Os and ^{192}Pt is discussed. It is concluded that the difference between the spectra of the two isotopes corresponds to the passage between two weakly deformed nuclei, one of which has a stable γ deformation (^{192}Os) and the other instable (^{192}Pt). (J.S.R.)

1682 INTERPRETATION OF Li^6(p,2p)He^5 AND Li^6(p,pd)He^4 REACTIONS AT MEDIUM ENERGY. Maurice Jean (Faculté des Sciences, Orsay, France). p.148-67 of "Physique Nucleaire des Basses Energies." Louvain, Belg., Librairie L. Wouters, 1962. (In French)

The formal aspects of the problems in the interpretation of ^{6}Li(p,2p)^{5}He and ^{6}Li(p,pd)^{4}He reactions were examined in some detail. The two extreme cases of the independent particle shell model and the alpha plus deuteron cluster model were considered for the (p,2p) reaction. Some results in the study of (p,pd) reactions that support the validity of the cluster model for ^{6}Li are summarized. (J.S.R.)

1683 STUDY OF CORRELATIONS IN LIGHT NUCLEI USING PION ABSORPTION. Maurice Jean (Faculté des Sciences, Orsay, France). p.168-83 of "Physique Nucleaire des Basses Energies." Louvain, Belg., Librairie L. Wouters, 1962. (In French)

The advantages and disadvantages in the study of correlations in light nuclei using pion absorption are briefly indicated. A schematic theoretical analysis of reactions of the type $\pi + {}^{A}X \rightarrow {}^{A-2}X + 2$ nucleons is outlined in order to give a precise idea of the experiments planned at Orsay. Capture followed by absorption of negative pions or absorption of positive pions in flight are both considered in the discussion. (J.S.R.)

1684 STUDY OF THE GIANT RESONANCE IN ^{11}B AND ^{16}O BY THE REACTIONS ^{9}Be(d,γ)^{11}B AND ^{14}N(d,γ)^{16}O. M. Suffert, G. Costa, and D. Magnac-Valette (CRN, Strasbourg). p.184-93 of "Physique Nucleaire des Basses Energies." Louvain, Belg., Librairie L. Wouters, 1962. (In French)

The experimental and theoretical results of the study of ^{9}Be(d,γ)^{11}B and ^{14}N(d,γ)^{16}O reactions using the 5.5-Mev Van de Graaff accelerator are summarized. The experimental apparatus is described. The de-excitation curve obtained for ^{9}Be(d,γ)^{11}B can be explained by the classical direct effect with plane waves. The results from the second reaction can be explained either by deuteron polarization or impurity of isotopic spin in ^{16}O. (J.S.R.)

1685 DECAY SCHEME OF In^{116}(13 SEC.). P. Fettweis and J. Vervier (Centre d'Etude de l'Energie Nucléaire, Mol, Belg.). p.205-10 of "Physique Nucleaire des Basses Energies." Louvain, Belg., Librairie L. Wouters, 1962. (In French)

The γ spectrum associated with the de-excitation of ^{116g}In was studied in order to determine if the excited levels decayed to excited levels of ^{116}Sn. The γ spectrum has two intense rays at 0.45 and 1.27 Mev, 2 low-intensity rays at 2 and 2.2 Mev, and a continuous distribution of γ rays between 0.45 and 1.27 Mev and above 1.27 Mev. The decay scheme of ^{116g}In is graphed. The energy, relative intensity, and log ft of the β^- transitions are given. (J.S.R.)

1686 DIRECT INTERACTION OF DEUTERONS, TRITONS, He^3, AND ALPHA PARTICLES. P. C. Macq (Université, Louvain, Belg.). p.211-19 of "Physique Nucleaire des Basses Energies." Louvain, Belg., Librairie L. Wouters, 1962. (In French)

Experimental and theoretical studies on the direct interactions of deuterons, tritons, ^{3}He, and α particles are reviewed. The total interaction mode of a particle with a nucleus is defined. (J.S.R.)

1687 RECENT DEVELOPMENTS IN BETA EMISSION. J. Deutsch. p.220-35 of "Physique Nucleaire des Basses Energies." Louvain, Belg., Librairie L. Wouters, 1962. (In French)

The present knowledge on weak interactions at low energy is discussed. The polarization of the β rays of ^{12}B measured as a function of their energy is shown. The G values are calculated from the matrix elements of once forbidden transitions. The role played by weak interactions in the study of nuclear structure is defined. The experimental data are reviewed with emphasis on the ease or difficulty of isolating the matrix element from the observations. (J.S.R.)

1688 ODD-ODD NUCLEI IN REGIONS OF GREAT DEFORMATION. J. Valentin (Laboratoire Joliot-Curie de Physique Nucleaire, Orsay, France). p.236-49 of "Physique Nucléaire des Basses Energies." Louvain, Belg., Librairie L. Wouters, 1962. (In French)

The properties of odd-odd nuclei in regions of great deformation are deduced. The production, lifetimes, ground state, rotation bands, moment of inertia, and probability of γ transition between rotation levels are discussed. These data, experimental and theoretical, are summarized for ^{166}Ho, ^{170}Lu, ^{172}Lu, ^{234}Pa, and ^{242}Am. (J.S.R.)

1689 CROSS SECTION AND COULOMB BARRIER IN RESONANCE REACTIONS. J. Humblet (Université, Liège) p.250-61 of "Physique Nucleaire des Basses Energies." Louvain, Belg., Librairie L. Wouters, 1962. (In French)

The study of resonance reactions by the method of complex eigenvalues is extended to the case where the cutoff of the Coulomb reaction for relatively wide separations of the reaction fragments is not introduced. The partial widths are thus affected by a factor that depends on the energy and that corresponds to the penetrability of the Coulomb barrier. Two types of development are proposed. The terms of the first type are completely independent of the rays of the processes. Those of the second type are dependent, but in an explicit fashion and exactly calculable. In these conditions, at each resonance level, a total width and partial widths that are independent of these rays can thus be associated. (tr-auth)

1690 CONTRIBUTION TO THE STUDY OF THE REACTIONS He^3(d,p)He^4, H^3(d,n)He^4, AND N^{15}(p,α)C^{12}. C. Mahaux (Université, Liège). p.262-71 of "Physique Nucleaire des Basses Energies." Louvain, Belg., Librairie L. Wouters, 1962. (In French)

Approximations with one and two levels without continuous background are introduced in the theory of resonance reactions proposed by Humblet and Rosenfeld. The results are compared with those deduced from the theory of the R matrix. The cross sections of the reactions ^{3}He(d,p)^{4}He, ^{3}H(d,n)^{4}He, and ^{15}N(p,α)^{12}C are analyzed with the aid of these formulas. (tr-auth)

1691 CALCULATION OF THE NUCLEAR SPECTRA OF TIN. Robert Arvieu (Laboratoire Joliot-Curie de Physique Nucleaire, Orsay, France), Elizabeth Baranger,

Marcel Veneroni, and Vincent Gillet. p.272-86 of "Physique Nucleaire des Basses Energies." Louvain, Belg., Librairie L. Wouters, 1962. (In French)

The nuclear spectra of tin isotopes are calculated using an interaction of the type commonly used in the calculation of the shell model. The parameters of the problem are derived, and the system of equations determining the canonical transformation is resolved. In a search for the best parameters, the mass difference between even and odd nuclei is investigated. The principal characteristics of the spectra of even tin nuclei are enumerated. (J.S.R.)

1692 ANALYSIS OF (1–) → (0+) BETA TRANSITIONS. P. Lipnik. p.287-304 of "Physique Nucleaire des Basses Energies." Louvain, Belg., Librairie L. Wouters, 1962. (In French)

The (1–) → (0+) β transitions of ^{170}Tm, ^{186}Re, ^{188}Re, and ^{210}Bi were analyzed and the results were presented. The experimental data are compared with the results obtained with the CVC theory. (J.S.R.)

1693 SIMPLE DIRECT INTERACTIONS AT MEDIUM ENERGY AND NUCLEAR STRUCTURE (p,2p; p,d; . . .). Pierre Radvanyi (Faculté des Sciences, Orsay, France). p.305-39 of "Physique Nucleaire des Basses Energies." Louvain, Belg., Librairie L. Wouters, 1962. (In French)

Experimental results on simple direct interactions are reviewed. Quasi-elastic scattering and pick-up reactions are compared. The experimental methods used at Orsay for (p,2p) and (p,d) reactions are described. Results for ^{9}Be, ^{10}B, ^{11}B, ^{16}O, ^{40}Ca, ^{6}Li, ^{12}C, and ^{139}La are reported and interpreted. (J.S.R.)

1694 LONG-RANGE INTERACTIONS AND ELECTROMAGNETIC TRANSITIONS IN SPHERICAL NUCLEI. G. Sartoris and J. Touchard. p.340-7 of "Physique Nucleaire des Basses Energies." Louvain, Belg., Librairie L. Wouters, 1962. (In French)

The shell model was used to calculate the branching ratios of transitions from 4+ levels. Only the simplified case where nucleons of a single type occupy a single shell of angular momentum j is considered. (J.S.R.)

1695 MECHANISMS OF REACTION BETWEEN HEAVY IONS. M. Demeur. p.348-53 of "Physique Nucleaire des Basses Energies." Louvain, Belg., Librairie L. Wouters, 1962. (In French)

The contribution of the physics of heavy ions to the knowledge of nuclear structure is reviewed, and some reaction mechanisms (mutual excitation in the reaction ^{12}C + ^{12}C and resonant transfer) are examined. (tr-auth)

1696 PHENOMENOLOGY OF NUCLEAR FORCES. L. Rosenfeld (Nordita, Copenhagen). p.355-75 of "Physique Nucleaire des Basses Energies." Louvain, Belg., Librairie L. Wouters, 1962. (In French)

The present knowledge on the phenomenology of nuclear forces is reviewed. The semi-phenomenological theories, repulsive core potentials, effective interactions in the nucleus, and non-local potentials are discussed. (J.S.R.)

Plasma Physics and Thermonuclear Processes

Refer also to abstracts 1163 and 1421.

1697 (AD-601417) PLASMA HEATING BY INJECTION OF CHARGED PARTICLES. Report No. 64-5. A. Hasegawa and C. K. Birdsall (California, Univ., Berkeley. Electronics Research Lab.). Mar. 13, 1964. Contracts AF33(657)-7614 and AF33(615)-1078. 192p. $3.00(OTS).

Obtaining a high-temperature plasma is a basic difficulty in problems of controlled fusion. Various methods have been proposed, such as injection of a stream of charged particles into the plasma. The work analyzes various processes that may occur in the energy conversion from stream to plasma. These processes are collision interactions and high-frequency interactions between the stream and plasma. More emphasis is given to the latter. (auth)

1698 (AFCRL-63-944) COUPLING OF MAGNETOHYDRODYNAMIC TO ELECTROMAGNETIC AND ACOUSTIC WAVES AT A PLASMA-NEUTRAL GAS INTERFACE. Scientific Report No. 1. S. L. Kahalas and D. A. McNeill (Mount Auburn Research Associates, Inc., Cambridge, Mass.). Oct. 31, 1963. Contract AF19(628)-2836. 53p. (AD-431635)

The coupling of magnetohydrodynamic waves to electromagnetic and sound waves at a plane interface between a plasma and a neutral gas is considered for arbitrary direction of the incident wave vector and for the constant external magnetic field lying either in the plane of incidence or perpendicular to it. The relations between the angle of incidence, reflection, and transmission, the ratio of the field amplitude transmitted or reflected to the corresponding amplitude incident, and the energy coupling coefficients are calculated. An incident fast magnetoacoustic mode generates a sound wave whose wave propagation vector makes an angle with the normal to the boundary of the order of the sound speed to Alfvén speed, when this ratio is small. In this case, the energy coupling coefficient of sound to the fast magnetoacoustic mode is also of the order of this ratio. An incident slow magnetoacoustic mode generates a sound wave with energy coupling coefficient of the order of unity, and an electromagnetic wave with energy coupling coefficient of the order of the ratio, speed of sound to speed of light. (auth)

1699 (ARC-CP-743) THE INFLUENCE OF GAS STREAMS AND MAGNETIC FIELDS ON ELECTRIC DISCHARGES. PARTS I AND II. V. M. Adams (Gt. Brit. Aeronautical Research Council). June 1963. 71p. (N64-29236). $2.80(BIS); 14s. (HMSO).

An experimental study of the motion and electric properties of a d-c arc moving round an annular gap under the action of a magnetic field is described. The dependence of the motion on the arc current, magnetic field and gap width is given for values up to 750 amps, 940 gauss, and 3.2 cm, respectively. The electrical characteristics of a fixed-current arc are given for fields up to 940 gauss. Photographic evidence of the arc rotation together with an indication of the shape of the conducting path are also included. The shape of the column of the d-c electric arc rotating in an annular gap between carbon electrodes is derived using a simple model for the arc, which is based on the concept of a solid conductor with uniform current density in a transverse uniform magnetic field and an opposing uniform flow field. It is shown that the shape for steady rotation is the involute of a circle, if the electromagnetic and aerodynamic forces are in equilibrium for all points along the arc. This shape is independent of the form of the expressions used for these two forces. The production of a plasma jet from the inner electrode arc root can, however, make the arc column straight for certain conditions. The derived shapes are compared with experimental results, and the simple model is confirmed for large gaps when the electrode effects are small. (auth)

1700 (IPPJ-21) PARTICLE ORBITS IN A HELIOTRON MAGNETIC FIELD. Tsuneo Amano, Masanori Murakami, and Akizi Outi (Nagoya, Japan. Univ. Inst. of Plasma Physics). July [1964]. 37p. Dep.(mn).

Numerical orbit integrations of charged particles in an axisymmetric Heliotron magnetic field were carried out on a computer. From the results of calculations, several characteristics of particle orbits, the adiabaticity of magnetic moment, and azimuthal drifts of particles are examined. The Heliotron confines plasma in a corrugated magnetic field having neutral points. (auth)

1701 (IPPJ-28) THE EFFECT OF FINITE ION LARMOR RADIUS ON THE ALFVEN WAVE INSTABILITY. Nobuo Yajima and Tosiya Taniuti (Nagoya, Japan. Univ. Inst. of Plasma Physics). July 1964. 9p. Dep. (mn).

It is shown that the finite ion Larmor radius has a

remarkable stabilization effect on the Alfvén wave instability (the fire hose instability). (auth)

1702 (JPL-TR-32-627) A SIMPLE PROOF OF THE IDENTITY OF LANDAU'S AND VAN KAMPEN'S SOLUTIONS OF THE LINEARIZED VLASOV EQUATION. Ching-Sheng Wu (California Inst. of Tech., Pasadena. Jet Propulsion Lab.). Apr. 15, 1964. Contract NAS-7-100. 7p.

In a generalized analysis, Case has shown that the electrostatic potentials obtained in Landau's and van Kampen's solutions to the collisionless Boltzmann equation are equivalent. The purpose of the report is to furnish a simple explicit proof of the complete identity of Landau's and van Kampen's solutions; the analysis, however, follows a course different from that of Case. (auth)

1703 (MATT-239) ENERGETIC ELECTRONS FROM A BEAM-PLASMA OVERSTABILITY. Thomas H. Stix (Princeton Univ., N. J. Plasma Physics Lab.). Feb. 1964. Contract AT(30-1)-1238. 70p. (CONF-471-41). Dep.(mn); $3.00(cy), 2(mn) OTS.

A detailed examination is made of a large-amplitude beam-excited electron cyclotron wave, and of the acceleration to high energies of favored electrons by the electric field of this wave. In laboratory experiments, x rays with energies greater than 100 kev have been observed coming from a plasma in a magnetic field, typically 2000 gauss, penetrated by an electron beam, typically one ampere at 10 kev. To account for the impressive energies reached by the electrons producing these x rays, an acceleration process is invoked in which individual steps of coherent cyclotron acceleration are summed stochastically. The increase in the perpendicular energy of the favored electrons enhances their magnetic mirror confinement and enables the acceleration process to occur within a small volume of plasma. The overstable mode under consideration is the double-hump-excited electrostatic wave in a magnetic field, with $\underline{k}$ and $\underline{E}$ not quite parallel to $\underline{B}_0$. The wave frequency is close to the electron plasma frequency, the phase velocity is close to the beam velocity. It is electrons, often with low parallel energy, that feel the wave at their own cyclotron frequency (or a harmonic thereof), which are favored in the acceleration process. The rapid growth of the electric fields to the large amplitudes requisite for the acceleration mechanism is difficult to account for, however, since electron trapping would be expected to occur and the linearized Vlasov-equation theory loses validity. An efficient untrapping process is invoked: the plasma is thought of as a conglomerate of wave regions invididually coherent but mutually incoherent. As an electron passes from one coherent region to another it is subjected to a new electric field randomly phased with respect to the first. A short correlation length improves our ability to account for overstability growth to large amplitude, but lengthens somewhat the calculated time for electron acceleration. Computations show efficient acceleration when the electron plasma frequency is of the same order or larger than the electron cyclotron frequency. (auth)

1704 (MATT-291) ON "BOHM-DIFFUSION" IN THE Q-1 DEVICE. N. D'Angelo (Princeton Univ., N. J. Plasma Physics Lab.). July 1964. Contract AT(30-1)-1238. 13p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Diffusion rates for highly ionized cesium and potassium plasmas across a magnetic field in the Princeton Q-1 device were studied. Observed flattening of the plasma radial density profiles when voltage is applied between the end plates is explained, and is taken as an indication of a transition from "classical" to "enhanced" ("Bohm") diffusion, which takes place when a sufficiently large current is supported by the plasma column. (R.E.U.)

1705 (ML-1200) NONLINEAR THEORY OF WAVES IN A COLD HOMOGENEOUS PLASMA WITHOUT MAGNETIC FIELD. R. H. Ball (Stanford Univ., Calif. Microwave Lab.). July 1964. Contract AF49(638)-1321. 174p.

The dynamic equations governing a plasma are inherently nonlinear, and general solutions to such nonlinear equations are not possible in most situations. Theoretical treatments are often developed only in the linear approximation, and a knowledge of the modifications to be expected from nonlinear effects is desirable. A perturbation theory is used, which reduces the nonlinear equations to a set of linear, inhomogeneous equations. The theory is formulated in such a way that each equation of the set describes a particular interaction between the several types of linear waves. The derivative-expansion method is used to eliminate the "secular" behavior that ensues from certain interactions, and to re-express this effect as changes in the amplitudes of the linear waves. The theory is applied to a model of a cold, homogeneous plasma in which collisions and ion motion are neglected and no d-c fields are allowed. There are three types of linear motions for this model: longitudinal plasma oscillations, electromagnetic waves, and a time-independent shear motion. The six possible second-order interactions of these waves are analyzed, along with the third-order interaction involving plasma oscillations. Some of the interactions can lead to progressive transfer of energy among waves or among the Fourier components of a given wave—the so-called "spectral decay." Interactions are studied in which electromagnetic waves are radiated, scattered, absorbed, and coupled parametrically to plasma oscillations; plasma oscillations are coupled to shear motion and to each other; shear motion is self-coupled and also scatters electromagnetic waves; and electromagnetic waves are coupled parametrically to each other via plasma oscillations. A statistical theory of plasma oscillations is formulated and applied to the emission of second-harmonic radiation by plasma oscillations. A random phase hypothesis is studied that simplifies the radiation formula so that it depends on the energy spectrum of the oscillations. This hypothesis makes possible numerical estimates of the parameters involved with radio noise bursts from the solar corona. The spectral decay of longitudinal plasma oscillations—a third-order effect—is studied for several situations, and the physical consequences analyzed. This includes the effect of the reaction to the emission of second-harmonic radiation, which may lead to spreading of the longitudinal oscillations in space as well as to their decay. A discussion is given of the relative importance of the various interactions and of some of the varied consequences that might arise. At least one of the interactions shows sufficient promise for a laboratory experiment to warrant further study. 66 references. (auth)

1706 (NASA-CR-53229) PROPAGATION AND DISPERSION OF HYDROMAGNETIC AND ION CYCLOTRON WAVES IN PLASMAS IMMERSED IN MAGNETIC FIELDS. Second Semiannual Status Report, July 15, 1963–January 14, 1964. Arwin A. Dougal (Texas. Univ., Austin). 30p. (N64-17352). $2.60(ph) OTS.

Basic theoretical and experimental research was continued in propagation and dispersion of hydromagnetic and ion cyclotron waves in plasmas immersed in magnetic fields. Three papers are abstracted. (N.W.R.)

For abstracts of individual papers see: 1707, 1708, and 1709.

1707 (NASA-CR-53229(p.15-22)) ANALYSIS OF WAVES IN BOUNDED MAGNETOACTIVE PLASMA. Y. J. Seto (Texas. Univ., Austin). (N64-17353)

Construction of a finite or semifinite domain Green's dyadic through complete sets of eigen functions makes possible solutions to the dyadic-vector Helmholtz equation describing waves in bounded magnetoactive plasma. The Green's dyadic method is applied to the analysis of radially traveling waves in a plasma slab bounded by two infinitely large, conducting, parallel plates, with a static magnetic field imposed upon the plasma in a direction normal to the surfaces of the boundary plates. The spatial variations of the electric and magnetic fields are determined. The Poynting vector for the near field zone, power dissipation, energy density, the energy velocity, and radiation resistance are calculated. The transition of the finite domain Green's dyadic to that of the infinite domain is discussed. (auth)

1708 (NASA-CR-53229(p.23-30)) CURRENT SHEATH DYNAMICS AND MAGNETOSONIC OSCILLATIONS IN

MAGNETOPLASMAS. Otto M. Friedrich, Jr. (Texas. Univ., Austin). (N64-17354).

Experimental and analytical studies of current sheath dynamics and magnetosonic oscillations in magnetoplasmas are reported. The dynamical behavior of a current sheath formed in preionized hydrogen (and argon) in an inverse pinch and accelerated through a steady stabilizing magnetic field is investigated with magnetic probes, piezoelectric probes, voltage-current probes, and Kerr cell photography. Magnetic probe and voltage-current data show evidence for magnetosonic oscillations of the current sheath which are predicted by numerical solutions of an equation of motion based on snow-plow model. Numerical calculations for the plasma parameters during the formation of a plasma in a cylindrical discharge with a line current located on the central axis are presented. Finite resistivity instabilities relevant to the experimental arrangement are discussed. (auth)

1709 (NASA-CR-53229(p.31-8)) RESONANCES AND WAVES IN ONE- AND TWO-ION SPECIES PLASMAS SUBJECTED TO INTENSE MAGNETIC FIELDS. Magne Kristiansen (Texas. Univ., Austin). (N64-17355)

The laboratory equipment for experimental research on resonances and waves in one- and two-ion species plasmas was assembled, tested, and placed into operation. The principal effects of interest are: resonant ion-plasma sheath interaction, resonant ion-nonresonant (impurity) ion interaction, and power absorption at the ion-ion hybrid wave for a two-ion species plasma. The experimental arrangement is described, and the preliminary experimental work is summarized. Analytical calculations of the resonant ion-plasma sheath interaction was initiated. The method by which the problem is being attached is outlined. (auth)

1710 (NASA-TN-D-2155) THE SHAPE OF A MAGNETICALLY ROTATED ELECTRIC ARC COLUMN IN AN ANNULAR GAP. James R. Jedlicka (National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.). Oct. 1964. 21p. $0.75 (OTS).

An electric arc discharge whirled in the annular gap between concentric, cylindrical electrodes by an external axial magnetic field is analyzed. A simplified model of the system is chosen, such that the arc is replaced by an impenetrable, conducting cylinder moving in a uniform fluid. At equilibrium the arc axis assumes a shape in which the driving electromagnetic force balances the retarding fluid-dynamic force. The equation for the shape is demonstrated to be the involute of a circle. For large magnetic field strengths, "diffuse discharge" operation is predicted. Comparison with experiment is good. The interpretation of arc photographs is discussed. (auth)

1711 (NASA-TN-D-2164) ELECTROMAGNETIC ACCELERATION OF A VARIABLE-MASS PLASMA. Donald J. Vargo (National Aeronautics and Space Administration. Lewis Research Center, Cleveland). Oct. 1964. 41p. $1.25(OTS).

Nonlinear one-dimensional rail-accelerator equations were solved with an analog computer by treating mass as a variable. (The rail mass-erosion coefficient was chosen from previously published vacuum-spark experiments.) Solutions are presented for ranges of three nondimensional parameters. Energy efficiencies of 40 to 55 percent were obtained for the best combination of the parameters considered. If switching were used to store the remaining system energy, theoretical first-cycle efficiencies of over 60 percent would be realized. (auth)

1712 (NASA-TN-D-2211) MONTE CARLO SOLUTION FOR THE CHARACTERISTICS OF A HIGHLY RAREFIED IONIZED GAS FLOWING THROUGH A CHANNEL WITH A TRANSVERSE MAGNETIC FIELD. Morris Perlmutter (National Aeronautics and Space Administration. Lewis Research Center, Cleveland). Oct. 1964. 23p. $0.75(OTS).

The steady flow of a highly rarefied ionized gas through a channel with a magnetic field normal to the channel wall is studied. The solution is obtained by a Monte Carlo procedure. This method consists of following sample ions through the channel. By tallying properties of these ions as they pass scoring cross sections of the channel, the various local properties of the flows such as density, mass flows, energies, and wall shear stress are obtained These results for the small magnetic field cases were compared with the limiting analytical solutions for no magnetic field and were in good agreement. (auth)

1713 (NP-14337) WILLS PLASMA PHYSICS DEPARTMENT SEVENTH SIX MONTHLY PROGRESS REPORT, JANUARY 1ST–JUNE 30TH 1964. (Sydney. Univ. School of Physics). 12p. (Pr-7) Dep.(mn).

The production and properties of plasma by SUPPER I and SUPPER II are summarized. Information is included on: the radial variation of parameters determining the velocity of hydromagnetic ionizing fronts in a cylindrical geometry, J × B plasma preparation in 0.1 to 1.0 torr pressure region, spectral studies of decaying plasmas, modulated dipole interferometry, microwave reflection from plasma, microwave interferometer studies of decaying plasma, studies of Alfvén waves in hydrogen plasma, propagation of waves near electron cyclotron resonance, and laser studies. (N.W.R.)

1714 (NP-14398) DENSITY PROFILES OF DECAYING HYDROGEN AND HELIUM PLASMAS. C. A. Hooker, L. C. Robinson, and L. E. Sharp (Sydney. Univ. School of Physics). Aug. 1964. 14p. (ER-10). Dep.(mn).

The distribution of plasma density in a cylindrical metal vessel was measured by the method of modulated dipole microwave interferometry. The resulting density profiles are presented and supported by framing camera photographs and measurements based on the Stark broadening of spectral lines. (auth)

1715 (NP-14402) LONGITUDINAL PROPAGATION OF A MICROWAVE BEAM IN A LABORATORY PLASMA NEAR THE CYCLOTRON RESONANCE. L. E. Sharp and C. A. Hooker (Sydney. Univ. School of Physics). Aug. 1964. 17p. (ER-11). Dep.(mn).

Experiments were performed on the propagation of an 8-mm microwave beam in a plasma parallel to the confining magnetic field. In the plasma both the electron density and magnetic field were varying slowly in time, allowing identification and separation of the left hand circularly polarized wave transmission band from the right hand circularly polarized wave transmission bands above and below the electron cyclotron resonance. The experimental data showed good agreement with the theoretical dispersion relations. (auth)

1716 (NP-14423) A RADIAL PLASMA GUN STUDY OF A HOLLOW LINEAR PINCH DISCHARGE. Rijnhuizen Report 64-21. L. Th. M. Ornstein (European Atomic Energy Community and Stichting Voor Fundamenteel Onderzoek der Materie. Instituut Voor Plasma-Fysica, Jutphaas, Netherlands). Sept. 1964. 84p. Dep.(mn).

A description is given of a hollow linear pinch discharge. A shell of hydrogen plasma with an electron density of 4×10^{14} cm^{-3} is produced by 24 titanium guns in the peripheral region of a discharge chamber. The plasma is contaminated with a few percent titanium. The flat cylindrical chamber consists of two steel flanges that serve as electrodes, and of an annular glass wall with a diameter of 39.5 cm and a height of 6 cm. After the formation of the shell, a condenser battery of 31 μF, initially charged to 18 kv, is discharged through the shell. An azimuthal magnetic field is connected with the axial discharge current. The Lorentz force causes the shell to constrict. Various diagnostic techniques were used to study the constriction: magnetic probes, millimeter waves, spectroscopical techniques, high-speed photography, etc. It is established that the shell, which has a thickness of 2.5 cm, constricts symmetrically in a time interval of 1.2 μsec into a column with a diameter of 3 cm. It is found that the shell obtains the shape of an hour-glass since the constriction proceeds more rapidly in the central plane than near the electrodes. The maximum constriction velocity in the central plane amounts to 6.5×10^7 cm sec^{-1}, corresponding to a kinetic energy of the hydrogen ions of 2.3 kev. The electron density in the constricted column is about 2×10^{16} cm^{-3}. No separation of

the hydrogen and the titanium fractions during the constriction is observed. The experimental results are compared with numerical computations of the constriction mechanism. The agreement is good. The experimental facility was used to study snow-plough pinches in hydrogen gas at various pressures. A comparison with the hollow pinch is made. It is proposed to utilize the hollow pinch as a radial plasma gun: the accelerated plasma shell can be made to pierce the equatorial magnetic barrier of a quasi-stationary, cusped magnetic field. The possibility of confinement of the plasma, trapped within the magnetic bottle, will be the object of future studies. (auth)

1717 (NP-14438) A MULTITEMPERATURE BOUNDARY LAYER. Research Report 184. Morton Camac and Nelson H. Kemp (Avoc Corp. Avco-Everett Research Lab., Everett, Mass.). Aug. 1964. Contract NASw-748. 26p.

Preliminary results are presented of an analytical investigation of the end wall boundary layer behind a reflected shock in a shock tube in highly ionized argon. Two nonequilibrium effects are considered: (1) chemical nonequilibrium because of finite recombination rates; and (2) lack of equilibrium between electron and heavy (atom and ion) particle temperatures because of a finite rate of energy exchange by elastic collisions between electrons and ions. In contrast with previous work in this area, the coupling between the electrical and the aerodynamic effects is retained, considering both simultaneously. The boundary layer is divided into two regions. Near the wall there is a plasma sheath whose thickness is several Debye lengths. The Debye length is small compared to the boundary layer thickness. In this sheath, the simple molecular description of the plasma originated by Langmuir and Mott-Smith is used. Outside the sheath, in the aerodynamic boundary layer, the usual continuum fluid mechanics treatment is used. These two descriptions of the plasma are joined at the sheath edge by requiring continuity of ion mass flux and electron energy flux, which serve as boundary conditions for the continuum boundary layer equations. The basic information determining the chemical kinetics and transport properties of ionized argon are well known, and they are employed to develop the set of boundary layer equations for the two-temperature case considered here. The solution of these equations is attempted by means of a local similarity approach, in which time is treated as a parameter, and the boundary layer equations are reduced to ordinary differential equations. Only a few solutions, all for frozen chemistry, are available at this stage of the investigation. They shown that when elastic energy exchange between ions and electrons is ignored, the electron temperature at the sheath edge is about half the external temperature. However, the solutions for no and complete elastic energy exchange show only a slight difference on the wall heat transfer rate. Further calculations for both frozen chemistry and finite recombination rate cases will be pursued. (auth)

1718 (NP-14442) ON RADIATIVE SHOCK STRUCTURE (thesis). Plasma Laboratory Report No. 9. Paul A. Koch (Columbia Univ., New York. School of Engineering and Applied Science). Mar. 1964. 174p.

A study was made of plane gas dynamic and transverse magnetogasdynamic shock waves in fully ionized hydrogen, at conditions such that radiative processes are significant. An established steady-state flow is found to exist for these waves only in astrophysical cases, since the wave thicknesses in such a flow are quite large. In the case of such an established flow, the Rankine-Hugoniot jump equation (i.e., the relation between the flow variables in the initial and final states) is analyzed and then solved numerically. It is shown that of the twelve roots of this equation only two are physical, corresponding to the supersonic initial and subsonic final states. The differential equations describing the shock waves are analyzed. The result is a set of four simultaneous nonlinear ordinary first-order differential equations, the solution of which gives the structure of the shock, i.e., the dependence of the flow variables on position within the shock wave. The structure equations are solved numerically for cases where the shock is optically thick, i.e., the mean free path for absorption of radiation is much smaller than the characteristic lengths for change of the flow variables. This is called the Eddington or diffusive approximation. A new criterion is given for the validity of this approximation in terms of the shock itself, independent of the properties of the atmosphere. Numerical results of radiative shock structure in this approximation are given. (auth)

1719 (ORNL-3696) STUDIES OF THE ION-CYCLOTRON RESONANCE INSTABILITY. G. K. Soper (Oak Ridge National Lab., Tenn.). Oct. 1964. Contract W-7405-eng-26. 139p. Dep.; $4.00(cy), 3(mn) OTS.

Thesis submitted to Univ. of Tennessee, Knoxville.

Plasma stability in the electromagnetic field of a "magnetic bottle" device is discussed. One particular micro-instability, the ion-cyclotron resonance instability, is discussed in detail. Its role in thermonuclear machines is described. Calculations regarding finite-geometry aspects of the theory and stable-unstable operating regimes are presented. A literature survey on ion-cyclotron resonance instability research is given. Dispersion relations are derived for four models: the infinite plasma model, the Harris model limited by the direction of the external magnetic field, the Burt-Harris model, and the Shima model. A CDC-1604A computer was used to determine regions of stability and growth rates (perturbative technique) for various temperature parameters. Observational results from specific thermonuclear devices are reviewed. A bibliography of 103 titles is included. (R.E.U.)

1720 (R64SD61) A CONSTANT CURRENT SHEET VELOCITY MODEL OF THE COAXIAL PLASMA ACCELERATOR. F. W. Mezger (General Electric Co. Missile and Space Div., Valley Forge Space Technology Center, King of Prussia, Penna.). Aug. 1964. 27p.

A one-dimensional macroscopic theory for coaxial electrode plasma accelerators is considered. The basic generic equations for such theories are derived from fundamental principles. In view of recent experience with efficient plasma accelerators indicating that they have a nearly constant current sheet velocity, the equations of motion for the case of a constant current sheet velocity are solved in closed form. Formulas for calculating energy and thrust efficiencies and specific impulse are given. Since no explicit formula for calculating the current sheet velocity is presented, the primary value of this theory is to serve as a basis for correlating and understanding experimental results. Possible extensions of the theory are discussed. (auth)

1721 (RT/FI(64)-8) MAGNETIC PROBES FOR MEASUREMENTS IN ELECTRICAL DISCHARGES IN GASES. A Boschi and G. B. Righetti (Italy. Comitato Nazionale per l'Energie Nucleare. Laboratori Nazionali, Frascati). June 1964. 12p. Dep.(mn).

Two types of magnetic probes are described. A first type, having a linear response on a wide frequency band, was designed for measurements in weak radio-frequency discharges. The second one, having an aperiodic functioning and a high sensitivity, was designed with the aim of measuring the weak magnetic fields in low pressure arcs. (auth)

1722 (RT/FI(64)-13) A SPACE-CHARGE-DOMINATED LOW-PRESSURE RADIOFREQUENCY PLASMA. A. Boschi, F. Magistrelli, and G. B. Righetti (Italy. Comitato Nazionale per l'Energia Nucleare. Laboratori Nazionale, Frascati). July 1964. 14p. Dep.(mn).

The behavior of radio-frequency low-pressure plasma is studied; it is characterized by a considerably high electron temperature and by a relatively low density (plasmoid), so as to make the Debye distance comparable with the plasma dimensions, this meaning that space-charge aspects are dominating. Measurements of the energies of the ions reaching the wall were performed by means of an

electrostatic cage; these are not in agreement with a stationary theory, possibly owing to the presence of ionic oscillations. A qualitative explanation for this is suggested. (auth)

1723 THEORY OF MICROFIELDS IN PLASMA. G. Kelbg (Universität, Rostock, Ger.). Ann. Physik (7), 13: 385-94(1964). (In German)

The probability distribution of the electric field in a plasma was determined by consideration of the particle interactions. With the aid of these distribution functions, the expectancy value of the square of the electric field strength was determined and the electric energy U_e was calculated. The energy $U_e = U_e^s + U_e^k$ is composed of two fractions, of which the first represents the self-energy of the charge carrier and the second relates to the particle interactions. The U_e^s corresponds to the Holtsmark approximation, and U_e^k leads to the Debye-Hueckel formula for the electric energy of a system of charged particles. (tr-auth)

1724 AN IMAGE TUBE CAMERA FOR PHOTOGRAPHY OF PLASMAS. A. E. Huston (Atomic Weapons Research Establishment, Aldermaston, Eng.). Appl. Optics, 3: 1231-4(Nov. 1964).

A camera has been designed around a specially developed image tube. It is primarily intended as a framing camera, but also may be operated as a streak camera. In the framing mode, it can record a sequence between eight and sixteen images, each with an exposure duration of 10 nsec, at a framing rate of 2×10^7 per sec. In the streak mode, the tube face can be swept in 50 nsec, giving an effective writing speed of 1500 mm/μsec. (auth)

1725 THERMONUCLEAR RESEARCH IN EUROPE. Andrew W. Kramer, ed. Atomics, 17: 44-7(Sept.-Oct. 1964).

Thermonuclear research in England and Germany is reviewed. The facilities available for this research in these countries are described. (T.F.H.)

1726 INVESTIGATIONS IN PLASMA PHYSICS AT THE INSTITUTE FOR PLASMA PHYSICS. H. L. Jordan (Kernforschungsanlage, Julich, Ger.). Atompraxis, 10: 427-32(Sept.-Oct. 1964). (In German)

A survey on the work carried out in the previous year on the production of high temperature plasma by means of fast magnetic compression and on the acceleration of plasma by conical ring discharge and magnetic traveling waves was given. The basic investigations and measurement methods used in these experiments were described. (tr-auth)

1727 THEORY OF LAYER WAVES IN LOW-PRESSURE GAS DISCHARGES. Karl Wojaczek (Physikalisch-Technische Institut, Deutsche Akademie der Wissenschaften, Berlin). Beitr. Plasmaphysik, 2: 49-65(1962). (In German)

The layer waves produced in the positive column of a low-pressure gas discharge in the transition regime by means of local, pulse-formed disturbances were conceived as wave packets of consecutive layers not disappearing instability increments. The dispersion and amplification behavior of stationary consecutive layers are known, therefore the characteristic data of the whole and individual layer waves could be calculated completely relative to their place and time dependence. The time parameters in the Peakarek theory of layer waves with regard to appearing gradient processes could be ordinarily determined so that the propagation rate and the half widths of the layer waves agreed with the values demanded by the dispersion theory. (tr-auth)

1728 THE RELATION BETWEEN STATIONARY EXCITED MOVING LAYERS AND LAYER-WAVES IN LOW-PRESSURE DISCHARGES. Milos Novak and Karl Wojaczek (Physikalisch-Technische Institut, Deutsche Akademie der Wissenschaften, Berlin). Beitr. Plasmaphysik, 2: 66-79(1962). (In German)

In a neon low-pressure discharge in the Pupp transition region both stationary consecutive layers and layer waves were excited under similar discharge conditions. The directly measured characteristic data for layer waves agreed with the values, which were calculated with the help of dispersion theory from the frequency state of layer width and amplification of stationary consecutive layers. (tr-auth)

1729 RADIAL TEMPERATURE RANGE IN STATIONARY AND PULSE-MODULATED ARGON HIGH-TEMPERATURE ARCS. Werner Neumann (Physikalisch-Technische Institut, Deutsche Akademie der Wissenschaften, Berlin). Beitr. Plasmaphysik, 2: 80-115(1962). (In German)

Investigations were made on a stationary and on a single-pulse-modulated 10-mm argon high-temperature arc. Arc arrangement, production and form of appearance of the pulse-modulated argon arc, electric parameters and current-voltage characteristics, electric field strength, total radiation and radiation yield per centimeter of arc length, energy equilibrium in high-temperature arcs, and methods for determining radial temperature distribution in high-temperature arcs are discussed. Data for radial temperature distribution are presented in graphs. An approximation was made to experimentally determined values by means of an energy balance equation. A maximum temperature of 15000°K was determined for stationary arcs and of 25000 to 27000°K for pulse-moderated arcs. (M.C.G.)

1730 TORCH DISCHARGES AND TORCH ARCS. V. Trunecek (Univ. of Brno). Beitr. Plasmaphysik, 2: 116-21(1962). (In German)

The characteristics of torch discharges are similar to the characteristics of glow discharges. If, in the torch discharge, a considerable amount of power is freed, such that the power melts and vaporizes the electrode, the characteristics of such a discharge change so that they resemble more the characteristics of an arc discharge. Therefore, these discharges are considered a new type of unipolar high-frequency discharge and are called torch arcs. The change of a torch discharge into a torch arc was studied by spectral analysis and by changes in the electrode. (tr-auth)

1731 EFFECTS OF THE SHAPE OF THE PRIMARY DISTURBANCE ON THE FORMATION OF LAYER WAVES IN LOW-PRESSURE GAS DISCHARGES. A. Rutscher and K. Wojaczek (Universitat, Greifswald, Ger. and Physikalisch-Technische Institut, Deutsche Akademie der Wissenschaften, Berlin). Beitr. Plasmaphysik, 2: 122-33(1962). (In German)

In low-pressure gas discharges, under certain operation conditions by means of a pulse-shaped single disturbance, so-called layer waves are excited, which are conceived as wave packets of consecutive layers. The primary disturbance, which releases layer waves, can in an extreme case have a three-dimensional δ-form, or in the other extreme case a transient δ-form. The layer waves belonging to these initial and boundary conditions were calculated for the same discharge conditions and compared with one another. It is shown that the essential characteristic data of both layer waves agree so well that the resonance wave number is smaller than the maximum amplification increment, d_ϑ. At $d_\vartheta = 0$ the characteristic data remained distinct, which characterized the symmetry relation of the layer waves. The case is also discussed in which the causing initial dusturbance results from a finite interception of the positive column. In the course of time the layer waves originating under these conditions take on still more the form of layer waves excited by a pure δ-form initial disturbance in the same disturbance place. (tr-auth)

1732 INTERPRETATION OF THE CONTROLLING TIME PARAMETERS FOR LAYER FORMATION IN ARGON AT HIGHER DISCHARGE CURRENT STRENGTHS. Milos Novak and Karl Wojaczek (Physikalisch-Technische Institut, Deutsche Akademie der Wissenschaften, Berlin). Beitr. Plasmaphysik, 2: 134-41(1962). (In German)

From the characteristic data for stationary excited consecutive layers in an argon discharge in the Pupp transi-

tion region, the characteristic time constants τ_1 and τ_2 were determined by combination of the Pekarek theory and the dispersion theory for two layer waves and corresponding discharge states. The corresponding discharge states. The corresponding Pekarek expression for this time constant was interpreted as the ion lifetime of excited atoms resulting from gradient ionization. A volume recombination coefficient on the order of 5×10^{-10} cm^2 sec^{-1} was ascertained. It was concluded that the lifetime of the excited atoms is determined by the ionized material and the concentration of excited atoms has a definite ratio to electron concentration. (tr-auth)

1733 LAYERED HIGH-FREQUENCY DISCHARGE IN NEON. Karl Wojaczek and Miloš Novák (Physikalisch-Technische Institut, Deutsche Akademie der Wissenschaften, Berlin and Inst. of Physics, Prague). Beitr. Plasmaphysik, 3: 1-11(1963). (In German)

In a long, cylindrical discharge tube of 3.1 cm cross section at a frequency of 1MH_2, high-frequency discharges in neon in the pressure region between 1 and 5 torr were produced and investigated with special regard to their layered state. By means of overlapping a weak direct current the migration rate of the layers could be varied according to size and direction. The migration rate for fixed discharge conditions was found to be proportional to the constant field strength, but was about an order of size greater than the drift velocity of ions in the same field. The quantitative layer data obtained for the region of the existence limits were supported, by use of direct-current analogy of the high-frequency current in the gas, by information on the internal discharge parameters. (tr-auth)

1734 PLASMA DIAGNOSTIC PROCEDURES. Werner Neumann. Beitr. Plasmaphysik, 3: 12-24(1963). (In German)

Methods of plasma diagnosis to determine macroscopic characteristic data for plasmas are described. Spectroscopic, microwave, and high-frequency diagnostic procedures and methods for determining gas temperature, density, pressure, electric field strength, magnetic field strength, electric conductivity, electron mobility, ion mobility, flow velocity of plasma components, mass flow rates, and thermal conductivity are discussed. Standardization of the translation, rotation, and vibration degrees of freedom and of the dissociation equilibrium is considered. The validity of the Boltzmann distribution for the electron term filling was tested, along with the validity of the Saha equation for degree of ionization for an optically thin plasma. (M.C.G.)

1735 STABILITY OF DISSIPATIVE PLASMA. PART I. H. E. Wilhelm (Technische Hochschule, Stuttgart). Beitr. Plasmaphysik, 3: 25-52(1963). (In German)

The stability behavior of axially symmetric plasma configurations with optional axial current density was investigated with regard to the dissipative transport processes (electric conduction, viscous pulse transport, thermal heat conduction, and energy transport by radiation mechanisms) according to the method of small current. Field equations are presented and the magnitude of transport discussed. Stability at a local disturbance was studied. (M.C.G.)

1736 MOTION OF A CHARGED PARTICLE THROUGH PLASMA. C. Devanathan and P. L. Bhatnagar (Indian Inst. of Science, Bangalore, India). Beitr. Plasmaphysik, 3: 107-21(1963).

The motion of a particle projected into an infinite stationary electron plasma. The interaction of the induced fields with the particle motion was considered along with treating the particle motion as mere point charge and current distribution. Apart from the field arising out of heaviside ellipsoidal charge distribution, there was a field propagated inside the "sound sphere" due to coupling between plasma-acoustic and plasma-electromagnetic modes. First-order particle-plasma interaction was taken into account. By consideration of acceleration and velocity of the particles, it was shown that these modes are chiefly responsible for any acceleration of the particle. It was also concluded that contribution to any radiation that might escape is also due to these modes. (auth)

1737 THE PROBLEM OF STANDING LAYERS IN HYDROGEN AND DEUTERIUM. Oto Štirand (Inst. of Physics, Prague). Beitr. Plasmaphysik, 3: 122-5(1963). (In German)

The influence of ion mass on the origin of standing layers in a discharge in molecular gases was investigated using hydrogen and deuterium gases. The effects of oxygen were determined. A definite mass effect was observed in the formation of standing layers and a greater amount of oxygen was necessary for the formation of standing layers in deuterium than in hydrogen. (M.C.G.)

1738 THEORY OF TRANSITION PHENOMENA IN DISCHARGE PLASMA. L. Pekárek (Inst. of Physics, Prague). Beitr. Plasmaphysik, 3: 126-32(1963). (In German)

The transition phenomena, which develop after a disturbance of small amplitude in a one-dimensional plasma, in which diffusion processes dominate over inertia effects, are described by a system of linear partial differential equations of general form. It is shown that this system can be approximately replaced by a partial intego-differential equation for a single variable, $Y_1(z,t)$, if the following conditions are met: the process described by this variable occurs more slowly than all the other processes and the solution of the subordinate system with $Y_1(s,t) = 0$ approaches zero for $t \to \infty$. (M.C.G.)

1739 ADJUSTMENT FOR DIRECTED MONOENERGETIC ELECTRONS IN THE MAXWELL DISTRIBUTION OF PLASMA ELECTRONS OF A Hg LOW-PRESSURE DISCHARGE. H. Behlke, H. Pupke, and J. Jaeger (Institut fur Biophysik, Deutsche Akademie der Wissenschaften, Berlin). Beitr. Plasmaphysik, 3: 133-60(1963). (In German)

An experiment was undertaken to determine flight distance of impacting electrons in various plasmas, which they must traverse in order to establish themselves in Maxwellian equilibrium with the plasma electrons. For the case considered, two empirical designations were found, which reproduce the dependence between this distance and the plasma parameters Ne (electron density), Te (electron temperature), Ng (neutral gas density), Upr (voltage rate of the impacting primary electrons), and Npr (density of the primary electrons). The standardization of the impact electrons in the Maxwell distribution is discussed. (tr-auth)

1740 SHORT REPORT ON PLASMA MICROFIELD. REMARKS ON A NOTICE. K. Hunger and R. W. Larenz (Technische Hochschule, Hanover). Beitr. Plasmaphysik, 3: 161-7(1963). (In German)

Critical comments on the microfield problem published by Hantzsche and Vojta (Beitr. Plasmaphysik, 2: 205(1962)) are considered to be mainly based on mathematical errors and physical misconceptions. General remarks about the problem are presented to illustrate the physical meaning of the Gaussian distribution for the microfield and related problems. (auth)

1741 NON-LINEAR THEORY OF LONGITUDINAL ELECTRON OSCILLATIONS IN PLASMA. Ronald Leven (Universität, Greifswald, Ger.). Beitr. Plasmaphysik, 3: 169-88(1963). (In German)

The intensification of electron oscillations by passage of a modulated electron beam through a plasma was considered in a non-linear approximation. It is shown that by suitable choice of the most important parameters, such as electron concentration, beam velocity, and temperature, a state of the system can be caused, producing an insignificant increase in electron concentration over a critical value and an intensification of the oscillation, in which the volumetric increase of the wave is so slight that the electron density can not be distinguished from its critical value. Examples are presented, which show that the amplitude of the oscillations of the electric field and the electron concentration increase with the energy of the injected electron beam. The assumptions made include: one-dimensionality of the problem, quasi-neutrality, motionlessness of the positive ions, and a collisionless plasma. (tr-auth)

1742 FORCE-EFFECT OF HIGH-FREQUENCY FIELDS ON PLASMA. Jiří Teichmann (Inst. for Vacuum Electronics, Prague). Beitr. Plasmaphysik, 3: 189-209 (1963). (In German)

In the frame of the magnetohydrodynamic approximation, the force exerted on a stationary plasma by a high-frequency field was considered. Special attention was devoted to the case of a plasma in an inhomogeneous static magnetic field. In the frame of the linearized theory, the expression for high-frequency force was derived, which represents the action of a high-impedance field as well as a configuration of a lower-impedance field. The possibility of the use of such force in magnetic bottles, especially with hyperbolic field geometry, is discussed. (tr-auth)

1743 AVERAGE FREE PATH LENGTH AND ONE-PLACE LENGTHS IN Hg LOW-PRESSURE DISCHARGES. H. Behike, J. Jaeger, and H. Pupke (Institut für Biophysik, Deutsche Akademie der Wissenschaften, Berlin). Beitr. Plasmaphysik, 3: 211-16(1963). (In German)

The possibility of determining the average free path lengths of electrons in plasma is discussed. It is shown that the free path length depends on the primary electron density and energy and on the gas pressure. For pressures of $p > 10^{-2}$ torr and electron densities of $N_e \lesssim 2 \times 10^{11}$ cm^{-3}, the collisions between primary electrons and gas particles are shown to be primarily responsible for the adjustment in the Maxwellian distribution, while at $p < 10^{-2}$ torr the exchange interactions, primary electrons–charge carriers and primary electrons–uhf vibrations dominate over the collision processes and the characteristic adjustment mechanism is not completely clear. (M.C.G.)

1744 OPERATING CONDITIONS FOR OSCILLATION-FREE LOW-PRESSURE GAS DISCHARGES. I. GENERAL VIEW. Karl Wojaczek and Alfred Rutscher (Physikalisch-Technisches Institut, Deutsche Akademie der Wissenschaften, Berlin and Ernst-Moritz-Arndt-Universität, Greifswald, Ger.). Beitr. Plasmaphysik, 3: 217-45(1963). (In German)

For operating current strengths between 10^{-5} and 10^{2} A in the pressure region between 10^{-1} and 10 torr, the various sources of self-excited disturbances of the direct-current discharge are reviewed. Possibilities for eliminating or working around these disturbances are discussed. Reactivity oscillations, cathode oscillations, column head oscillations, oscillations of the positive column, stenotron oscillations, and anode oscillations are described and ways of eliminating them outlined. Sound, moving layer, and spiral waves are considered. The coupling of various oscillation types is discussed. Roar phenomena are also described. (M.C.G.)

1745 INVESTIGATION OF TIME-WISE CHANGES OF NORMAL CATHODE FALLS OF A GLOW DISCHARGE IN NEON WITH A POLYCRYSTALLINE MOLYBDENUM CATHODE. Peter Pech (Physikalisch-Technische Institut, Deutsche Akademie der Wissenschaften, Berlin). Beitr. Plasmaphysik, 3: 247-56(1963). (In German)

Measurements were made of the change with time of a normal cathode fall over several hundred operating hours in a tube filled with neon and with a polycrystalline molybdenum cathode. The possible causes of these changes were studied. The construction and preparation of the discharge tube are described. Data are presented in graphs. (M.C.G.)

1746 DETERMINATION OF FORCE-FREE MAGNETIC FIELDS FROM THE VALUE FOR FIELD STRENGTH. Fritz Krause (Institut fur Magnetohydrodynamik, Deutsche Akademie der Wissenschaften, Jena, Ger.). Beitr. Plasmaphysik, 4: 1-9(1964). (In German)

The force-free magnetic field was determined from the value of the field strength H. Complete solutions are given for H = constant and for those cylindrically symmetric fields, whose values are pure functions of the length of the axis of symmetry. (tr-auth)

1747 LAYER PHENOMENON OF LOW-PRESSURE DISCHARGES IN NEON–HYDROGEN MIXTURES. S. Pfau and A. Rutscher (Ernst-Moritz-Arndt-Universität, Greifswald, Ger.). Beitr. Plasmaphysik, 4: 11-20(1964). (In German)

At a constant total pressure (1.8 torr) the characteristic size of the layers of a low-pressure discharge in the region of small disturbance strength was determined in relation to the mixing ratio (Ne/H_2). On the positive moving layers of the neon discharge, small amounts of hydrogen (on the order of 10^{-2}%) had a measurable influence. The maximum amplification of this layer increased with increasing H_2 content. Higher percentages (about 10%) caused a damping so that a homogeneous column resulted. For still larger H_2 admixtures, the column showed negative moving as well as undamped standing layers. The relationship between standing and moving layers, as was already determined in pure gases, could be further developed. (tr-auth)

1748 ANALOGY CONSIDERATIONS TO TWO-DIMENSIONAL PROBLEMS IN MAGNETOHYDRODYNAMICS. K.-H. Raedler (Institut für Magnetohydrodynamik, Deutsche Akademie der Wissenschaften, Berlin). Beitr. Plasmaphysik, 4: 21-31(1964). (In German)

In the frame of magnetohydrodynamics and with restriction to two-dimensional problems, equations were derived, which determine the behavior of a magnetic field for given movement of a conducting medium. They showed an analogy to the equations that describe the mixing of dissimilarly composed moving media or the heat transfer in a moving medium. From the standpoint of this analogy, the question of a two-dimensional magnetohydrodynamic dynamo is discussed. Stationary magnetic fields in shearing, flowing, conducting media were ascertained by calculation of analogous temperature fields. (tr-auth)

1749 MAGNETOHYDRODYNAMIC GENERATORS OF THE HALL TYPE. Ludwig Rothhardt (Institut für Magnetohydrodynamik, Deutsche Akademie der Wissenschaften, Jena, Ger.). Beitr. Plasmaphysik, 4: 33-9(1964). (In German)

For hot, weakly ionized gas, which flows through magnetic fields, Ohm's law in its elementary form is no longer valid. The treatment of magneto-hydrodynamic generators, which utilize the effect of higher than first order in flow and field, must therefore proceed from a generalized Ohm's law in tensorial form. Besides, it was also observed that a current driven by the Hall effect in the gas can influence these dynamics. Three generators in which the Hall effect essentially determines the mode of operation, are described. (tr-auth)

1750 OPERATING CONDITIONS FOR OSCILLATION-FREE LOW-PRESSURE GAS DISCHARGES. II. EXISTENCE REGION OF POSITIVE COLUMNS WITHOUT MOVING LAYERS. Alfred Rutscher and Karl Wojaczek (Ernst-Moritz-Arndt-Universität, Greifswald, Ger. and Physikalisch-Technische Institut, Deutsche Akademie der Wissenschaften, Berlin). Beitr. Plasmaphysik, 4: 41-59 (1964). (In German)

The homogeneity region of long positive columns and the existence region of moving layers are reviewed. The layer-free regions in pure rare gases, in pure metal regions, in molecular gases, and in gas mixtures are described. (M.C.G.)

1751 ENERGY TRANSFERS IN STATISTICAL TREATMENT OF MAGNETOHYDRODYNAMIC TURBULENCE. P. Schwartz and G. Wallis (Heinrich-Hertz-Institut, Deutsche Akademie der Wissenschaften, Berlin). Beitr. Plasmaphysik, 4: 61-9(1964). (In German)

The results of spectral and fluctuation theories of magnetohydrodynamic turbulence were compared with regard to energy transfer. For the spectral method a distinction is permitted between when the turbulence energy is smaller or larger than the kinetic energy and when it is equal to it; such a classification does not appear evident in the simple fluctuation evaluation. The statistical additional assumptions of Kraichnan are discussed in their kinetic significance. It is shown how a hypothesis on the interaction of the individual modes of turbulence is based on the interaction of the Fourier components of the distribution function. (tr-auth)

1752 MAGNETOHYDRODYNAMIC DESCRIPTION OF SMALL-AMPLITUDE PLASMA WAVES. J. Wilhelm (Institut für Gasentladungsphysik, Deutsche Akademie der Wissenschaften, Greifswald, Ger.). Beitr. Plasmaphysik, 4: 111-23(1964). (In German)

The magnetohydrodynamic description of plasma waves of small amplitude was formulated for the most general conditions (electric anisotropy, viscosity, non-adiabatic equation of state, and heat transfer). It was found that in the most common case magneto-acoustic waves do not oscillate in a plane fixed by the propagation direction and the magnetic field, but in a direction which is decided by electric anisotropy. The initial equation, a formulation of the dispersion equation, and a solution of the dispersion equation are presented. (M.C.G.)

1753 ATTENUATION OF ALFVEN WAVES IN RELATIVISTIC MAGNETOHYDRODYNAMICS. Rudolf V. Deutsch (Babes-Bolyai-Univ., Cluj). Beitr. Plasmaphysik, 4: 125-30(1964). (In German)

The attenuation of Alfven waves, when these waves propagate in media with arbitrary anisotropy, was studied. Equations are presented and used for the case in which the plasma is two-component, completely ionized, and nonrelativistic, and only the wave is relativistic. Results are presented in the form of equations. (M.C.G.)

1754 DISSIPATIVE TENSORS OF COMPLETELY IONIZED PLASMAS IN A STRONG MAGNETIC FIELD. Rudolf V. Deutsch and Zoltan Gabos (Babes-Bolyai-Univ., Cluj). Beitr. Plasmaphysik, 4: 131-6(1964). (In German)

Dissipative tensors of completely ionized plasmas were calculated, beginning with the kinetic equations for a completely ionized two-component plasma. It was assumed that the deviation from the Maxwellian equilibrium distribution is small. (M.C.G.)

1755 MEASUREMENT OF THE PHASE SHIFT BETWEEN ELECTRON CONCENTRATION AND LIGHT INTENSITY IN THE MOVING LAYERS OF POSITIVE COLUMNS IN RARE GASES. Vítězslav Veselý (Charles Univ., Prague). Beitr. Plasmaphysik, 4: 149-54(1964). (In German)

Systematic measurements were made of the phase shifts between the transient course of light intensity (electron temperature) and the electron concentration in moving layers in neon and helium. Results are presented in tables and graphs. (M.C.G.)

1756 NOISE MEASUREMENT IN LOW-CURRENT LUMINOUS ARCS IN THE MICROWAVE REGION. Helmut Prinzler (Heinrich-Hertz-Institut, Deutsche Akademie der Wissenschaften, Berlin). Beitr. Plasmaphysik, 4: 155-63 (1964). (In German)

Studies were made of the electron temperature in plasma columns and on elementary processes in the electrode region by noise measurements on different arc forms. Results are presented in tables and graphs for three electrode arrangements. (M.C.G.)

1757 CONTRIBUTION TO THE THEORY OF CATHODE FALLS. E. Hantzsche (Physikalisch-Technisches Institut, Deutsche Akademie der Wissenschaften, Berlin). Beitr. Plasmaphysik, 4: 165-208(1964). (In German)

A one-dimensional theory for the cathode fall region of the glow discharge was developed, based on Boltzmann equations for electrons, positive ions, and fast neutral molecules, and on simple empirical relations for the impact cross sections and secondary emission coefficients. The equations were solved numerically for the case of anomalous discharges in H_2 (5 and 10 kv), and the results are presented graphically, together with results of previously calculated elementary models. Some ideas concerning two-dimensional theory and stability questions are proposed. (auth)

1758 DETERMINATION OF THE PARAMETERS OF A CESIUM PLASMA USING A LANGMUIR PROBE. Eugène Dieulesaint and Jean-Baptiste Moreau (Compagnie Francaise Thomson-Houston, Paris). Compt. Rend., 259: 741-4 (July 27, 1964). (In French)

A diode tube provided with a Langmuir probe and furnishing, by contact ionization, a cesium plasma was fabricated. From the characteristics of the probe, the temperature, electron density, and plasma potential were determined. The nature of the space charge in the vicinity of the electrodes was deduced. (tr-auth)

1759 CONFINEMENT TIMES FOR A HOT PLASMA IN A MAGNETIC WELL. André Biguet, Pierre Blanc, René Gravier, Pierre Lecoustey, Henri Luc, Claude Renaud, Jean Tachon, Didier Véron, and Bruno Zanfagna (Commissariat à l'Énergie Atomique, Fontenay-aux-Roses, France). Compt. Rend., 259: 1040-3(Aug. 3, 1964). (In French)

The lifetime of a plasma (whose ionic temperature was evaluated at 1 kev) was measured in a magnetic mirror configuration with and without superposition of a quadrupole field. The value of the ratio of the kinetic pressure of the plasma to the magnetic pressure varied from 10^{-4} to 10^{-2}. The maximum lifetime was 230 μsec for a density of 10^{10} ions/cm^3. (tr-auth)

1760 ACCUMULATION OF ENERGETIC PLASMA USING TWO STRUCTURES SIMULTANEOUSLY ACCELERATING AND BEING A DYNAMIC PLUG. René Bardet, Tèrenzio Consoli, and Richard Geller. Compt. Rend., 259: 1044-7(Aug. 3, 1964). (In French)

It is shown that the h-f and static magnetic field gradient structure used in plasma accelerators possesses the inverse property of reflecting a plasma beam that ascends the magnetic field gradient. Plasma accumulation using two similar accelerators, each constituting for the other a dynamic plug or resonant mirror, is described. (tr-auth)

1761 DIFFRACTION OF AN ELECTROMAGNETIC PLANE WAVE BY A CYLINDER OF INHOMOGENEOUS PLASMA. Paul-Étienne Faugeras (EURATOM-CEA, Fontenay-aux-Roses, France). Compt. Rend., 259: 1311-14(Aug. 10, 1964). (In French)

The diffraction of an electromagnetic wave by a plasma cylinder having revolution symmetry in the case of a plane wave at normal incidence and of polarization parallel to the axis of the cylinder was studied. By a self-consistent method, different from the Born approximation, the exact expression of the field scattered by the plasma, regardless of the density distribution, was obtained. (tr-auth)

1762 OSCILLATIONS OF PLASMA IONS IN THE CATHODE REGION OF GLOW DISCHARGE. M. Borisov, G. Stainov, and N. Martinov. Compt. Rend. Acad. Bulgare Sci., 17: 9-12(1964). (In Russian)

Coherent oscillations in a glow discharge, caused by ion plasma oscillations in the region of cathode potential drop, were studied. A cylindrical discharge tube with a ring-shaped cathode and two anodes and with input voltages to 5 kv was used. Experiments were carried out in Ne, Ar, and He at pressures of 1 to 10^{-2} torr and with Al, Cu, and Fe cathodes. Results show that coherent ion plasma oscillations are present in a glow discharge and that their frequency decreases with the ion-oscillation frequency calculated by the Tonks-Langmuir formula. (M.J.T.)

1763 STRUCTURE OF THE PERTURBED ZONE IN THE VICINITY OF A SMALL CHARGED BODY IN A PLASMA. A. V. Gurevich. Geomagnetizm i Aeronomiya, 4: 3-16(1964).

The effect of a positively charged spherical body on a rarefied plasma was investigated. The electron and ion densities were calculated. (D.C.W.)

1764 ELECTROMAGNETIC ACOUSTICAL DISPERSION RELATIONSHIP AND THE EFFECT OF SUPERLUMINAL AND RADIATION DOPPLER FREQUENCIES OF A MOVING DIPOLE IN A STRATIFIED PLASMA. Musa Yildiz (Raytheon Co., Wayland, Mass.). J. Electron. Control (1), 17: 241-55(Sept. 1964).

The propagation of coupled, electromagnetic and plasma (acoustical) waves generated by a moving and oscillating dipole in an infinitely long, compressible, plasma cylinder surrounded by vacuum is investigated. The fields of the moving sources can be decomposed into two modes—the

electromagnetic mode and the plasma (acoustic) mode. These two modes are coupled on the plasma-vacuum boundary. The electric dipole may excite pure, longitudinal, plasma waves since the plasma mode is associated with charge accumulation, but not with a magnetic field. It is shown that if an oscillating dipole of frequency ω_0 (when $\Omega = \omega - \omega_0$) moves along the axis of the plasma cylinder, it modifies radial wave-numbers of electromagnetic waves in such a way that both the electromagnetic and the plasma (acoustic) waves may propagate without decaying. The coupled plasma and electromagnetic waves do not form a radiation cone analogous to a Cherenkov cone. Requirements for coupled, non-evanescent waves in optical and acoustical spectra are given, respectively, by the expressions: $\cos\theta_0 = \Omega/v[c/(\omega^2 - \omega_p^2)^{1/2}] \leq 1$ and $\cos\theta_\alpha = \Omega/v[3kT/m(\omega^2 - \omega_p^2)]^{1/2} \leq 1$. If $\cos\theta_0 \leq 1$, then the above relation for θ_0 will hold only for radiation Doppler frequencies, and if $\cos\theta_\alpha \leq 1$ then, similarly, the above expression for θ_α will (may) hold for both superluminal Doppler frequencies ($\Omega = \omega + \omega_0$) and radiation Doppler frequencies ($\Omega = \omega - \omega_0$). The various aspects of the wave phenomena involving coupled, electroacoustical waves are determined by examining the dispersion relations corresponding to superluminal Doppler frequencies and radiation Doppler frequencies. (auth)

1765 EXCITATION OF ELECTRO-ACOUSTICAL WAVES IN A TWO-FLUID COMPRESSIBLE PLASMA. S. N. Samaddar (Raytheon Co., Bedford, Mass.). J. Electron. Control (1), 17: 267-72(Sept. 1964).

A two-fluid (electrons and ions) isotropic homogeneous compressible plasma is described by linearized hydrodynamic and Maxwell's equations with electromagnetic sources. It is shown in general that under suitable assumptions these equations can be decomposed into EM-modes and P-modes (longitudinal or acoustical modes). Using these decomposed fields the generalized Poynting vector is derived. The usefulness of such a method of separation into EM-modes and P-modes in boundary value problems is emphasized. A simple radiation problem is considered in order to check the results with recent work done in a completely different way. Though the total fields can be decomposed into two modes, it is shown that the P-modes are made up of coupled ion and electron pressure waves. When the equivalent relative dielectric constant becomes negative, the EM-mode does not propagate in an unbounded compressible plasma, whereas the P-mode does. However, in an unbounded one-fluid compressible plasma, neither the EM-wave nor the P-wave can propagate when its equivalent dielectric constant becomes negative. (auth)

1766 INFLUENCE OF COULOMB CORRELATION ON THE SCATTERING OF X-RAY BY AN ELECTRON GAS. I. RPA APPROXIMATION. Yoshihiro Ohmura and Noboru Matsudaira (Tokyo Univ.). J. Phys. Soc. Japan, 19: 1355-60(Aug. 1964).

The effect of the Coulomb correlation on the line profile of the x ray which is scattered inelastically by an electron in the degenerate electron gas was calculated. The calculation is performed by making use partly of the dielectric formulation in random phase approximation and partly of the canonical transformation method. The effect is quite small for large angle scattering, but for small angle scattering it becomes essential. Particularly for the angle where the momentum transferred to the photon is smaller than the plasma cut off momentum, the scattering is interpreted as the excitation of plasma oscillation. The discrepancy between the experimental value of the line width and the calculated value by Donovan and March cannot be explained by the Coulomb correlation. A brief indication for the future experiments is given. (auth)

1767 NEGATIVE ABSORPTION AT THE CYCLOTRON FREQUENCY IN WEAKLY IONIZED GASES. Shigetoshi Tanaka (Nagoya Univ., Japan) and Kenji Mitani. J. Phys. Soc. Japan, 19: 1376-84(Aug. 1964).

The negative absorption at the electron cyclotron frequency in weakly ionized gases is examined under the following conditions: The plasma is so tenuous that its refractive index is close to unity and plasma electrons have a spherically symmetric distribution function in velocity space. Also the effective collision frequency for momentum transfer is dominantly due to the collision of electron with neutral particles and varies with speed v as $\nu(v) \propto v^h$. The condition of negative absorption is given by $h > 3$ for the electron distribution function $f(v) \propto \delta(v - v_0)$ and $q + 3 > h > 3$ for $f(v) \propto v^q \exp(-bv^l)$. The absorption coefficient, the radiation temperature, and the radiation intensity corresponding to the negative absorption are derived, and their characteristics are discussed in detail. (auth)

1768 SPACE CHARGE EFFECT ON THE ACCELERATION OF ELECTRONS IN A THETA-PINCH. Masatomo Sato and Ichiro Kawakami (Nihon Univ., Tokyo). J. Phys. Soc. Japan, 19: 1499(Aug. 1964).

Hard x rays of several hundred kev were previously observed in theta-pinch experiments indicating that electrons of kinetic energies of the order of the electron rest energy are contained in the discharge tube. The possible effects of the radial space charge field, which would act to give a stationary orbit of nearly constant radius as the appropriately designed magnetic field does in a betatron, are proposed. (C.E.S.)

1769 VARIOUS METHODS USED FOR THE STATISTICAL IDENTIFICATION OF PLASMA. János Szabó (Technical Univ. of Heavy Industry, Miskolc, Hungary and Loránd Eötvös Univ., Budapest). Magy. Fiz. Folyoirat, 12: 241-4(1964). (In Hungarian)

Two basically different methods are used for describing and identifying the properties, the physical behavior, and the phenomena occurring in the plasma. The phenomenological method, designated as magnetohydrodynamics, presents the advantage of being based on relatively simple equations to which specific physical meaning can be ascribed; in most cases, the values of interest may be measured directly. The equations are derived from those of hydrodynamics and the electromagnetic theory. However, the method does not clarify the internal mechanisms of the phenomena. Such an explanation may be derived by making use of the kinetic theory or the statistical theory of the plasma which makes it possible to attribute specific physical meaning to the basic equations of magnetohydrodynamics. The behavior of the individual particles is given by the Liouville equation; this can be approximated by the Boltzmann equation, assuming that the interaction of the particle is negligible small with respect to the volume. In view of the long-range action of the electromagnetic forces, the Boltzmann equation is indeed applicable because each particle is surrounded by a Debye-type charge cloud of the opposite sign. This results in the decrease of the collision cross section and the increase of the mean free path of the particles. The ions with their charge cloud are considered "quasi-particles" and are well identified by the Boltzmann-Vlasov statistics. (TTT)

1770 TEMPERATURE BEHAVIOR IN A LINEAR PINCH DISCHARGE. W. Mueller (Arbeitsstelle fur Statistische Physik, Leipzig). Monatsber. Deut. Akad. Wiss. Berlin, 6: 486-91(1964). (In German)

Under the assumption that during the heating processes a stable pressure balance prevails, a simple pinch model was used to study the transient behavior of the temperature. From this it was assumed that the plasma produces Joule heat and emitts recombination radiation and bremsstrahlung. (tr-auth)

1771 PLASMA OSCILLATIONS. II. KINETIC THEORY OF WAVES IN PLASMAS. Ira B. Bernstein (Princeton Univ., N. J. and EURATOM-CNEN, Frascati, Italy), S. K. Trehan, and M. P. H. Weenink. Nucl. Fusion, 4: 61-104(June 1964).

The small longitudinal oscillations of an infinite, homogeneous, collisionless plasma are investigated first. The model requires that the frequency of collisions, Coulomb or other, be much smaller than the characteristic frequencies and growth rates of the system. The general theory is applied to an investigation of the stability of such systems and the polarization of its environment by a test

charge. The latter provides the basic data for a heuristic theory of the non-equilibrium statistical mechanics of plasmas, which yields, for instance, a derivation of the Fokker-Planck equation with polarization corrections and a treatment of fluctuation phenomena in plasmas. The latter is applied to the theory of the scattering of light by plasmas. The phenomenon of Landau damping as treated both by the Laplace-transform technique and the normal-model technique, and the equivalence of both methods is shown. A special class of finite-amplitude electrostatic waves is treated, and its relation to the normal modes of the linearized equations is given. Also, plasma oscillations of a large number of electron beams are considered, and the limit of an infinite number of beams is shown to yield the results of a plasma with a continuous velocity distribution. (auth)

1772 FLUTE INSTABILITY OF AN AXIALLY SYMMETRIC PLASMA WITH A FINITE ION LARMOR RADIUS. A. B. Mikhailovskii (Kurchatov Inst. of Atomic Energy, Moscow). Nucl. Fusion, 4: 108-13(June 1964). (In Russian)

The necessary and sufficient conditions are found for which first-mode instability is possible. In addition to remoteness of the housing, two other conditions must be fulfilled: the density $\underline{n}$, pressure $\underline{p}$ and radius of curvature $\underline{R}$ must be linked by the relation $(Rr)^{-1}\,\partial p/\partial n \approx$ const; and away from the center, the density must decrease faster than $1/r^2$. If only one of these conditions is not fulfilled and the plasma is not too dilute ($C_A^2 \ll C^2$) the stabilization effect occurs even for a perturbation with $\underline{m} = 1$. An example of a distribution that is stable with respect to perturbations with any $\underline{m}$ is given. (auth)

1773 EQUILIBRIUM OF A PLASMA COLUMN THAT DOES NOT POSSESS AXIAL SYMMETRY. V. D. Shafranov (Kurchatov Inst. of Atomic Energy, Moscow). Nucl. Fusion, 4: 114-24(June 1964). (In Russian)

The equilibrium position of a plasma column of circular cross section inside an ideally conducting housing is calculated for the case in which the axis of the plasma column (or the housing) represents a space curve. The model of a plasma column with a sharp boundary and a surface current is used. The solution is obtained in the form of a Fourier series expansion over the arc length of the column axis. For the case in which the curvature is a smooth function of the arc length, simple formulas are obtained for the displacement of the column axis with respect to the axis of the housing, the validity of which, for the case in which the housing has the shape of a racetrack, is confirmed by numerical calculation of the displacement by general formulas. Use of the same method of Fourier-series expansion permits solution of even the problem of the distortion of the plasma column caused by transverse slits in the housing that are necessary for the introduction of the electric field into the discharge volume in which plasma is created. Results are given for distortions by slits in a toroidal housing. (auth)

1774 POSITIVE MERCURY COLUMN IN A LONGITUDINAL MAGNETIC FIELD. L. L. Artsimovich, A. V. Nedospasov, and S. S. Sobolev (Kurchatov Inst. of Atomic Energy, Moscow). Nucl. Fusion, 4: 125-30(June 1964). (In Russian)

Plasma current convection of a positive gas discharge column was previously studied under diffusion conditions for which the free path lengths of the electrons and ions (λ_e and λ_p) were smaller than the radius α of the tube. The results are given of experiments with a positive mercury column at a pressure of 2 to 4×10^{-3} torr, for which λ_e and $\lambda_p \ll \alpha$. In addition, for a solenoid of length L = 20 cm, $\lambda_e > L$ for low pressures. Under these conditions, the hydrodynamic theory that does not consider ion inertia is inapplicable, and new mechanisms of inhomogeneous plasma instability are possible, among them mechanisms that are not connected with the longitudinal current. (auth)

1775 COMPARISON OF THETA PINCHES WITH TRAPPED MAGNETIC FIELDS OF DIFFERENT POLARITIES AND MAGNITUDES. P. Bogen, E. Hintz, and J. Schlueter (Kernforschungsanlage, Julich, Ger.). Nucl. Fusion, 4: 131-6(June 1964).

A theta pinch with deuterium at 0.23 torr, a 60-kgauss peak magnetic field and a 1.8-μsec half cycle were investigated. Three cases were observed: an initial bias field of zero, +2kgauss, and −2 kgauss. With −2 kgauss the usual axial contraction and heating rates of 1 kev/μsec were found. Both the incident and reflected axial shocks were measured; they did not cause the trapped field to disappear or significantly increase the plasma radius, even though the density increased by 2. With +2 kgauss, β is a few per cent; and the plasma follows the field lines. Here, the electron temperature T_e is less than 80 ev. With zero field, a rarefaction wave runs into the plasma, causing a density increase by 2 and a plasma diameter decrease. With zero field and −2 kgauss, electron temperatures were comparable, indicating that diffusion heating is also important in high-β cases ($\beta \approx 0.8$). The x-ray and optical plasma radii agree within 1 mm. When the time dependences of the electron density and temperature are compared, it becomes questionable whether the soft x rays used for the determination of T_e are thermal. With zero and −2 kgauss fields, discharge cleaning reduced impurities to $\lesssim 0.1\%$, and the reverse field and relatively high β persisted through the entire half cycle. The usual abrupt reverse-field disappearance was observed with a few per cent impurity. (auth)

1776 NON-LINEAR MODEL OF PROGRESSIVE ELECTROMAGNETIC WAVES IN THE PRESENCE OF A MAGNETIC FIELD. C. Brossier (EURATOM-CEA, Fontenay-aux-Roses, France). Nucl. Fusion, 4: 137-44 (June 1964). (In French)

For an infinite homogeneous plasma, a model of progressive electromagnetic waves propagating parallel to an external magnetic field that is constant and uniform is constructed. In the limit at which the amplitude of the wave approaches zero, the classical dispersion relation is found again by means of a method for avoiding the usual singularity. (auth)

1777 ANOMALOUS PLASMA DIFFUSION IN ION CYCLOTRON RESONANCE. V. V. Chechkin, M. P. Vasilev, L. I. Grigoreva, and B. I. Smerdov (Inst. of Physics and Tech., Khar'kov). Nucl. Fusion, 4: 145-51(June 1964). (In Russian)

The enhanced diffusion of a low-temperature plasma across the lines of force of a constant homogeneous magnetic field under conditions of high-frequency heating at a frequency approaching the ion cyclotron frequency was investigated experimentally. (D.C.W.)

1778 A NEW PRINCIPLE OF ION EXTRACTION FROM A GAS DISCHARGE PLASMA. O. Reifenschweiler and K. R. Froehner (Phillips Research Labs., Eindhoven, Netherlands). Nucl. Instr. Methods, 30: 298-302(Nov. 11, 1964).

A principle of ion extraction from gas discharge plasmas is described and discussed, in which the plasma boundary, which acts as an ion emitting surface, is fixed with respect to its shape and position by a grid (emission grid) at the plasma potential. Unlike previous ion extraction systems, the ion optical properties of the system may be chosen at will and do not depend on the extraction voltage. With the system a saturation current of several mamp can be extracted at an extraction voltage above 100 kv in the form of a well focused ion beam. The principle can be applied to sealed-off neutron generator tubes; an output of more than 10^{10} neutrons per second should then be reached. (auth)

1779 PLASMA POWER ABSORPTION IN THE HIGH FREQUENCY ION SOURCE. Andrzej Lipinski, Henryk Malecki, and Andrzej Marczewski. Nukleonika, 9: 705-13 (1964). (In Polish)

Plasma power absorption of the ion source was measured. Two methods were applied: calorimetric and electric. Agreement of the results obtained by both methods was quite good. Power absorption dependence upon pressure in a plasma chamber imitating an ion source was measured. This second dependence was measured by the electric method also. (auth)

1780 A MODEL OF OPTICALLY DENSE PLASMA WITH A GENERALIZED SOURCE FUNCTION. I. THE CONTOUR AND INTEGRAL INTENSITY OF A SPECTRAL LINE. N. G. Preobrazhenskii. Opt. Spectry. (USSR) (English Transl.), 17: 4-7(July 1964). Translated from Optika i Spektroskopiya, 17: 8-11(July 1964).

A new, generalized model is proposed for inhomogeneous, optically dense plasma. In contrast to previous models, the model makes it possible to take account of differences in the dimensions of the coaxial spatial zones in which the spectral lines are emitted, contraction of the discharge column, and the Townsend electron density gradient. A theory of the contour and integral intensity of a line is developed on the basis of the new model. (auth)

1781 IMPEDANCE OF RF GRIDS AND PLASMA CONDENSERS. M. R. Feix (Langley Research Center, Hampton, Va.). Phys. Letters, 12: 316-17(Oct. 15, 1964).

The impedances of a pair of grids through which electrons can pass freely, and of a plasma-filled condenser, are analyzed. The similarity of the results for these cases lead to the conclusion that measurements of the impedance of these devices provides an opportunity for testing the microscopic theory of plasma waves. (T.F.H.)

1782 PRODUCTION OF PLASMA BY INJECTION OF CHARGED HYDROGEN CLUSTERS. W. Henkes (Kernforschungszentrum, Karlsruhe, Ger. and Technische Hochschule, Karlsruhe, Ger.). Phys. Letters, 12: 322-3 (Oct. 15, 1964).

A calculation of plasma buildup by collisional processes is carried out, for the case of injection of clusters of hydrogen molecules into the plasma region. It is found that the injection of the molecules in 300-molecule clusters increases the trapping efficiency by a factor of 2.5 over the case of continuous injection of atomic hydrogen. (T.F.H.)

1783 NECESSARY AND SUFFICIENT CRITERIA FOR STABILITY OF LOW-PRESSURE PLASMA. C. Brossier, G. Laval, R. Pellat, and M. Vuillemin (Commissariat a l'Energie Atomique, Fontenay-aux-Roses, France). Phys. Letters, 12: 327-8(Oct. 15, 1964). (In French)

The stability of a collisionless plasma in a strong magnetic field is studied. The particle dynamics are described by the Vlasov equation in the limit of small mass-to-charge ratio. The Maxwell equation is written in terms of power expansions of the plasma properties in powers of β (the ratio of ion kinetic energy to magnetic energy). The assumed conditions make β small. The plasma is supposed neutral, and the inertia of the electrons is neglected. (T.F.H.)

1784 EXCITATION OF ION-ACOUSTIC WAVES. R. W. Gould (Institut fur Plasmaphysik, Garching, Ger.). Phys. Rev., 136: A991-7(Nov. 16, 1964).

The excitation of ion-acoustic waves by a pair of idealized grids in a collisionless plasma is examined. It is shown that in a limited region, neither too close nor too far from the source, the disturbance closely approximates an exponentially damped (spatially) ion-acoustic wave. Far from the source a weak electron wave with less damping and larger wavelength dominates; near the source the potential varies as 1/z. (auth)

1785 DEVICE FOR GENERATING AN ALKALI PLASMA IN THERMODYNAMIC EQUILIBRIUM (PETER). L. Enriques and F. Magistrelli (EURATOM–CNEN, Rome) Rev. Sci. Instr., 35: 1708-11 (Dec. 1964).

A device for generating an alkali plasma in thermodynamic equilibrium is described. It consists of a cylindrical tantalum cavity which is made incandescent by means of electron bombardment. The plasma obtained by contact ionization on the walls has a density varying from 10^{10} to 10^{12} cm^{-3} at a temperature of 2600°K, and is free from temperature, density, and potential gradients. A series of coaxial tantalum screens surrounds the cavity with the purpose both of limiting the supplied power and of making the cavity temperature uniform. The testing of the apparatus by means of a hot probe is also described. (auth)

1786 NUCLEAR FUSION AND ITS ROLE AS AN ENERGY SOURCE. J. G. Linhart (Laboratorio Gas Ionizzati, Frascati, Italy). Scientia (6), 58: 1-5(1964).

It is outlined how the interest in controlled nuclear fusion developed and how the corresponding research concentrated on the long confinement of plasma. It is pointed out that in view of technological advances on fission reactors, ideas on fusion reactors have to be revised. Although it is impossible to evaluate the economic aspects of fusion power generation—because no reactor of this kind has been constructed—it is possible to make several general observations, based on known physical limitations in plasma confinement and heating. It is concluded that economic fusion devices must be simple and that explosion-type fusion device may well satisfy this requirement. Other uses of fusion energy are also mentioned. (auth)

1787 CURRENT STABILITY IN A TRANSVERSE MAGNETIC FIELD. A. F. Nastoyashchii. Teplofiz. Vysokikh Temp., 2: 321-8(1964).

The current stability relative to quasi-neutral oscillations in a dense electron-ion plasma was investigated, using a quasi-gas dynamic approximation that includes neutral gas friction effects. (D.C.W.)

1788 ELECTRICAL AND OPTICAL INVESTIGATIONS ON LINEAR PINCH DISCHARGES AT HIGH DENSITIES. Fritz Dieter Erbslоeh (Technische Hochschule, Hanover). Z. Physik, 180: 449-69(1964). (In German)

From the comparison of kinematographic pictures and experimentally determined current density distributions, it was shown that the pinch process at high initial density must be explained by a collision wave model. It was shown that the partial current that was carried by the heated column possesses a significant pressure dependence. It reaches, with increasing initial pressure, a maximum that deteriorates at medium pressure and decreases sharply at higher densities. At the highest initial pressures investigated, the optically visible column is completely current-free. The decrease of the column current corresponds to an increase of the hydromagnetic stability of the heat column in the transition to higher initial densities. In the discharges, boundary currents were detected that were displaced in their phase with respect to the total current. This phase displacement was explained by comparison with the skin effect of the straight wire. Wall processes should significantly participate in the origin of the boundary current. (tr-auth)

1789 PLASMA PHYSICS AND THERMONUCLEAR THEORY. Albert Simon (General Atomic Div., General Dynamics Corp., San Diego, Calif.). p.5-68 of "Lectures from the Second Neutron Physics Conference, Boyne Mountain, Michigan, June 1962." Ann Arbor, Mich., Michigan Memorial-Phoenix Project, 1964.

The nature of the instabilities which cause plasma to escape containment in very short times are discussed. The basic requirements for a controlled fusion reactor, plasma stability, the motion of single particles, the single particle approach to plasma stability, and the energy principle are considered. (C.E.S.)

1790 COMMENTS ON THE FAST MAGNETIC COMPRESSION OF PLASMAS. Alan C. Kolb (Naval Research Lab., Washington, D. C.). p.70-155 of "Lectures from the Second Neutron Physics Conference, Boyne Mountain, Michigan, June 1962." Ann Arbor, Mich., Michigan Memorial-Phoenix Project, 1964.

Cylindrically symmetric, high-current electrodeless discharges (the θ pinch), the hydromagnetic equations for a fully ionized plasma, the source terms in the energy balance equations, Alfvén waves, plasma heating mechanisms, numerical solutions of the MHD equations, and experimental results on the magnetic compression of deuterium plasma in a θ pinch are discussed. (C.E.S.)

1791 APPLICATION OF SINGULAR EIGENFUNCTION EXPANSION METHODS TO PROBLEMS IN PLASMA OSCILLATIONS. Roman Zelazny (Case Inst. of Tech., Cleveland). p.157-84 of "Lectures from the Second Neu-

tron Physics Conference, Boyne Mountain, Michigan, June 1962." Ann Arbor, Mich., Michigan Memorial-Phoenix Project, 1964.

The application of singular eigenfunction expansion methods to the study of plasma phenomena is investigated. An attempt is made to obtain a solution of the initial value problem for longitudinal plasma oscillations for the case when ions are treated as a positive charge background. Properties of Cauchy integrals, the linearized Vlasov equation, the general solution, completeness and the initial value problem, the initial value problem for longitudinal and transversal plasma oscillations, and the homogeneous Hilbert problem are considered. (C.E.S.)

1792 EMISSION OF MICROWAVES FROM PLASMAS. George Bekefi (Massachusetts Inst. of Tech., Cambridge). p.7-23 of "Engineering Aspects of Magnetohydrodynamics." New York, Gordon and Breach Science Publishers, 1964.

The elementary emission and absorption processes and the macroscopic state of the radiating medium are discussed in an attempt to construct a model of a radiating plasma. The classical model of a radiating plasma and a model for a plasma not in thermodynamic equilibrium are considered. Experiments made on plasmas with non-Maxwellian distributions are discussed. A bibliography of 45 references is included. (C.E.S.)

1793 THE MEASUREMENT OF SHAPED PROBING BEAMS IN MICROWAVE PLASMA DIAGNOSTICS. Paul H. Wolfert (Sylvania Electronic Systems, Buffalo). p.37-55 of "Engineering Aspects of Magnetohydrodynamics." New York, Gordon and Breach Science Publishers, 1964.

The interpretation of plasma microwave beam diagnostics by means of the geometric optical model is discussed. The influence of a field perturbation on the received signal, apparatus for the measurement of the field transfer function, interpretation and evaluation of the records, and the measurement of shaped probing beams are considered. (C.E.S.)

1794 A VERSATILE MICROWAVE DIAGNOSTIC SYSTEM FOR PLASMA STUDIES. F. J. F. Osborne (RCA Victor Co., Ltd., Montreal). p.57-64 of "Engineering Aspects of Magnetohydrodynamics." New York, Gordon and Breach Science Publishers, 1964.

A fast-acting microwave diagnostic system which was developed for use with non-repetitive plasmas such as those in shock tubes and pulsed discharges is described. The system may be used for either reflection or transmission measurements and gives a polar display of phase and amplitude in conjunction with timing marks. Some of the features of the system are wide dynamic range, expansion of high attenuation regions of the display, and a presentation of data which is readily assessed visually. The accuracy of phase information is increased over that of the fringe shift interferometer. (C.E.S.)

1795 ELECTROMAGNETIC WAVE PROPAGATION THROUGH INHOMOGENEOUS PLASMAS IN THE PRESENCE OF APPLIED MAGNETIC FIELDS. Rodney Mason and Richard R. Gold (Aerospace Corp., Los Angeles). p.65-88 of "Engineering Aspects of Magnetohydrodynamics." New York, Gordon and Breach Science Publishers, 1964.

The general problem of the propagation of an electromagnetic wave through an ionized gas is considered, including collisions, some form of electron density distribution, and a magneto-statically induced anisotropy. A brief review of the fundamental equations is presented, including a summary of the electron density distributions for which complete wave theory solutions exist, and an outline of the W.K.B. approximation. Specific analytical solutions and appropriate numerical calculations are derived. The analysis includes a consideration of inhomogeneous, uniform, magnetoactive plasmas and the effect of nonuniformities in the field. (C.E.S.)

1796 MODERN PROBE TECHNIQUES FOR PLASMA DIAGNOSIS. Sol Aisenberg (Raytheon Co., Waltham, Mass.). p.89-126 of "Engineering Aspects of Magnetohydrodynamics." New York, Gordon and Breach Science Publishers, 1964.

A review of some of the more valuable probe techniques for plasma diagnosis is given, and their advantages and limitations are discussed. Examples of information that can be deduced from probe data are given, and techniques for reducing errors in measurement and interpretation are discussed. The theory of the Druyvesteyn probe method is presented along with experimental results. An improved theory for the collection of positive ions by a negative probe in a plasma is presented. Probe measurement techniques for probes in plasmas in magnetic fields are also considered. (C.E.S.)

1797 A PLASMA CONDUCTIVITY PROBE. Edmund C. Lary and Robert A. Olson (United Aircraft Corp., East Hartford, Conn.). p.127-40 of "Engineering Aspects of Magnetohydrodynamics." New York, Gordon and Breach Science Publishers, 1964.

The method of measurement of plasma conductivity described involves the use of a small movable probe containing an inductor, the magnetic field of which penetrates into the plasma surrounding the probe. It consists of a cylindrical, single-layer solenoid enclosed within an insulating tube and is used in conjunction with an r-f oscillator-detector to measure the ohmic dissipation of a small amount of r-f power in the fluid. Since the magnetic field diminishes rapidly with distance from the coil, the conductivity in the immediate vicinity of the probe is sampled. The probe may be moved about in the plasma in order to resolve spatial variations of plasma conductivity. The fact that the probe surface is an insulator implies that the influence of Hall effects and electrostatic sheaths may be effectively eliminated. (C.E.S.)

1798 A WAY TO MEASURE PLASMA DENSITY—THE "PLASMA SWEEPER." I. Alexeff and R. V. Neidigh (Oak Ridge National Lab., Tenn.). p.141-52 of "Engineering Aspects of Magnetohydrodynamics." New York, Gordon and Breach Science Publishers, 1964.

The method, called the plasma sweeper, which provides a simple method of measuring ion density in a magnetically supported plasma column, is described. Measurements are made by turning off the source of plasma, then sweeping out the plasma ions along the magnetic field and collecting them. This measurement gives the amount of plasma initially present. Knowing the volume the plasma initially occupied, one computes the average plasma density. Experimental measurements are discussed. (C.E.S.)

1799 THE IMAGE CONVERTER AS A TOOL FOR SHORT TIME SPECTROSCOPY. Richard T. Schneider (Institut fur Hochtemperaturforschung, Stuttgart). p.153-66 of "Engineering Aspects of Magnetohydrodynamics." New York, Gordon and Breach Science Publishers, 1964.

The use of spectroscopic techniques for temperature measurements in high temperature plasmas is discussed. It is shown that there are two main problems in short-time spectroscopy: attaining short exposure times and light amplification. An attempt is made to show how the image converter can alleviate these problems. (C.E.S.)

1800 TRAVELING WAVE PLASMA ENGINE PROGRAM AT NASA LEWIS RESEARCH CENTER. Robert E. Jones and Raymond W. Palmer (Lewis Research Center, Cleveland). p.383-99 of "Engineering Aspects of Magnetohydrodynamics." New York, Gordon and Breach Science Publishers, 1964.

The traveling wave plasma engine program is outlined. The investigation of the magnetic waves produced by coaxial polyphase coil systems, the experimental apparatus, and the experimental procedures and results are discussed. (C.E.S.)

1801 AN EXPERIMENTAL INVESTIGATION OF THE ARC-ION PROPULSION CONCEPT. P. J. Dickerman (Univ. of Chicago), P. R. Bell, and J. E. Francis, Jr. p.401-4 of "Engineering Aspects of Magnetohydrodynamics." New York, Gordon and Breach Science Publishers, 1964.

A description is given of the arc chamber and associated apparatus. Experimental work to determine the values for thrust, velocity, mass flow rate, and the dependence of the

stream conditions on the confining magnetic field are discussed. The problem of a plasma stream flowing through a diverging magnetic field is also considered. (C.E.S.)

1802 EXPERIMENTAL INVESTIGATION OF THE CONFINED PARALLEL RAIL PULSED PLASMA ACCELERATOR. Michel E. Maes (Rocket Research Corp., Seattle). p.439-64 of "Engineering Aspects of Magnetohydrodynamics." New York, Gordon and Breach Science Publishers, 1964.

The capabilities and potential of the pulsed plasma accelerator as a practical propulsion system were investigated. (C.E.S.)

1803 EXPERIMENTS WITH A HIGH SPECIFIC IMPULSE CROSSED-FIELD ACCELERATOR. S. T. Demetriades (Northrop Corp., Hawthorne, Calif.). p.507-25 of "Engineering Aspects of Magnetohydrodynamics." New York, Gordon and Breach Science Publishers, 1964.

Experimental results obtained with crossed-field plasma accelerators are presented. Observations of the discharge in the accelerator, the effect of higher magnetic fields, the effect of confinement, the location and stagger of electrodes with respect to the magnetic field, and erosion of insulators are discussed. Theoretical expressions for the current density and thrust are also presented. (C.E.S.)

1804 EFFECTS OF HALL CURRENTS ON THE PERFORMANCE OF CROSSED FIELD MHD ACCELERATORS. R. L. Fredrickson and J. C. Wu (Douglas Aircraft Co., Santa Monica, Calif.). p.527-37 of "Engineering Aspects of Magnetohydrodynamics." New York, Gordon and Breach Science Publishers, 1964.

Considerations are given to the existence of Hall currents in accelerators employing uniform electric and magnetic fields, and an expression is derived for achievable thrust increments. Theoretical results obtained from the analysis are found to be in close agreement with experimental data. The successful prediction of experimental results from a theory which includes the Hall current loss mechanism alone implies that in some accelerator configurations other loss mechanisms such as boundary layer phenomena and end effects can be unimportant in comparison. (C.E.S.)

1805 NEW EXPERIMENTS WITH HOLLOW CATHODE DISCHARGES (FOR APPLICATION TO PLASMA ACCELERATORS). Richard H. Weinstein and Robert V. Hess (Langley Research Center, Hampton, Va.). p.539-50 of "Engineering Aspects of Magnetohydrodynamics." New York, Gordon and Breach Science Publishers, 1964.

Results intended to give a more quantitative description of hollow cathode operation and the prerequisite conditions for uniform discharges are discussed. Pyrometric observations of the cathode are presented showing the dependence of the average cathode surface temperature on current. Various possibilities concerning emission effects above the thermionic level can be inferred from the temperature data. Comparison of several electrode configurations shows heat transfer from the cathode to have important effects on the operation of the discharge. All experiments were made with an unseeded discharge making it possible to evaluate the effect of surface conditions on discharge behavior. (C.E.S.)

1806 PLASMA STRESS TENSOR ON A WALL. Norman C. Jen (City Coll., New York). p.551-8 of "Engineering Aspects of Magnetohydrodynamics." New York, Gordon and Breach Science Publishers, 1964.

The relative motion between a wall and a plasma that is Maxwellian at a large distance from the wall is investigated. The plasma is assumed to be moving toward the stationary wall along an arbitrary direction, and magnetic field effects are disregarded. (C.E.S.)

1807 PRELIMINARY OBSERVATIONS OF RF POWER TRANSFER TO A HYDROGEN PLASMA AT FREQUENCIES NEAR THE ION CYCLOTRON FREQUENCY. Clyde O. Swett and Roman Krawec (Lewis Research Center, Cleveland). p.599-614 of "Engineering Aspects of Magnetohydrodynamics." New York, Gordon and Breach Science Publishers, 1964.

Apparatus and methods were developed to determine the amount of r-f power transferred continuously to a hydrogen plasma. Reflected-resistance, light-output, and electron-density measurements were made at constant r-f current of 22 amp (which resulted in powers up to 2 kw), constant frequency of 6.5 Mc, pressures from 0.5 to 2.0 microns, and electron densities of about 10^{11} electrons/cc. Results show that the resistance reflected into the circuit increased with pressure and power transfer efficiencies as high as 50 to 60 per cent were noted without resorting to special techniques. There was a resonance identified as the point of maximum power transfer to the plasma which occurred at magnetic fields about 18 to 47 per cent greater than that corresponding to ion cyclotron resonance for atomic hydrogen ions. Light-intensity and electron-density measurements showed similar behavior. A possible explanation for this shift in the resonant point is that a mixture of atomic and molecular ions will show a resonant point different from that of either ion. Further experimental evidence is needed to verify the concept of two ion species being present in the plasma. (auth)

1808 ELEMENTS OF THE DCX-2 EXPERIMENT. Robert J. Mackin, Jr. (Oak Ridge National Lab., Tenn.). p.615-22 of "Engineering Aspects of Magnetohydrodynamics." New York, Gordon and Breach Science Publishers, 1964.

The design and performance of each of the 5 major components, or sub-systems of the DCX-2 machine, are described including the ion source and accelerator, the magnet, the vacuum, the trapping plasma, and the magnetically shielded injection channel. An outline of the prospective experimental program is included. (C.E.S.)

1809 REACTION KINETICS OF DEUTERIUM–TRITIUM MIXTURES. William N. Huss (Massachusetts Inst. of Tech., Cambridge). p.623-44 of "Engineering Aspects of Magnetohydrodynamics." New York, Gordon and Breach Science Publishers, 1964.

The behavior of the kinetic reactions of deuterium–tritium plasmas reveals the actual critical temperatures to which a plasma must be heated to give a significant thermonuclear reaction. The variation of the reaction rate parameters for the D–D and D–T reactions coupled with the variation of the escaping radiation with temperature, cause the plasma to have two equilibrium points of operation. If the transmission factor of the cyclotron radiation is large, no operation of a cyclic reactor will be possible. The equilibrium point at the higher temperature is a stable point of operation while the equilibrium point at the lower temperature is an unstable operating point. The position of the upper equilibrium point is quite dependent upon the magnitude of the cyclotron radiation transmission factor. If the transmission factor of the cyclotron radiation was high, the thermonuclear reaction would stop. A rather low transmission factor of the order of $\tau = 0.01$ must be obtained if successful operation of a cyclic reactor is to be obtained. The actual critical temperatures to which the plasma must be heated were found, and small variations in the transmission factor had little effect on the initial temperature requirements. (auth)

1810 STUDY OF THERMONUCLEAR PROPULSION USING SUPERCONDUCTING MAGNETS. Gerald W. Englert (Lewis Research Center, Cleveland). p.645-71 of "Engineering Aspects of Magnetohydrodynamics." New York, Gordon and Breach Science Publishers, 1964.

Application of superconducting magnets to a pyrotron type thermonuclear reactor is discussed. The thermonuclear rocket utilizing a D–T reaction and superconducting magnets offers no decided advantage over the fission electric rocket. Utilization of a D–^{3}He reaction, however, shows substantial gain over the fission electric rocket. A two-shield system is needed to get specific impulses of the order of 10^4 sec. The shield more remote from the reactor can supply energy directly to a propulsion mass. The energy to the primary shield must, however, be removed in a manner not involving additional propulsion mass. The suggested system is the conversion of this energy to electricity via a turboelectric generator for the D–T case, but direct rejection of this energy to space by a radiator for the

D–^{3}He case. The large percentage of energy of a D–T reaction given off in neutrons makes the shields and thus turboelectric system and the cryoplant of such size that the thrust–weight ratio of the engine is limited to approximately 10^{-4} for a specific impulse of 10^4 sec. The higher percentage of confined energy of the D–^{3}He reaction offers promise of increasing this beyond 10^{-3}. The successful realization of a thermonuclear rocket, in the advent of controlled thermonuclear reactions, may depend on the successful parallel development of a suitable means of converting the energy of high temperature plasmas into jet power. Use of the D–T reaction and a pyrotron geometry requires a good understanding of shielding high energy neutrons, and an increase of current carrying capacity of superconducting material to about an order of magnitude greater than in the present state of the art. Use of a D–^{3}He reaction is dependent on good self absorption of cyclotron radiation by the plasma. (auth)

1811 NUCLEAR FUSION METHOD. Kenneth William Allen (to United Kingdom Atomic Energy Authority). U. S. Patent 3,152,958. Oct. 13, 1964. Priority date Sept. 2, 1957, Great Britain.

A nuclear fusion reactor for the deuterium-tritium reaction was designed. It consists of a vessel for containing deuterium and tritium, means for heating the gas to a kinetic temperature at which fusion reactions occur between deuterium and tritium, and a blanket of ^{6}Li and ^{7}Li surrounding at least part of the vessel. The fusion reaction can be written as D + T → ^{4}He + n + 17.6 Mev. Electric power can be obtained directly from the fusion reaction by interaction between the fast alpha particle released in the D + T reaction and the magnetic field used to contain the discharge. A method of breeding more tritium than is used in the reactions by reaction of neutrons produced in the fusion reaction with lithium in the blanket was developed. (M.C.G.)

Shielding

Refer also to abstract 780.

1812 (HW-81746(p.2.36-8)) FAST NEUTRON SHIELDING. K. L. Swinth (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Measurements were made of the asymptotic transmission, Be^{-Lt}, of small shields of paraffin, concrete bricks, and wood for neutrons at 4.5 and 14.5 Mev. Data are presented in graphs. (auth)

1813 (ORNL-TM-817) FORTRAN AND CODAP LISTINGS FOR ZAP-1. A CDC-1604 Computer Program to Calculate Radiation Dose Near a Spherical Source. P. A. Thompson, S. A. Lewis, and T. G. Clark (Oak Ridge National Lab., Tenn.). Nov. 1964. Contract W-7405-eng-26. 51p. Dep.(mn); $3.00(cy), 1(mn) OTS.

A FORTRAN 62 and CODAP-1 program, ZAP-1, was written for the CDC 1604 computer for the calculation of depth dose in tissue from a nearby spherical radioactive source. The listings for the ZAP-1 program are given. (auth)

1814 (ORNL-TM-953) OGREISH-P1—A MONTE CARLO CODE UTILIZING IMPORTANCE SAMPLING FOR THE COMPUTATION OF GAMMA-RAY TRANSMISSION THROUGH LAMINATED SLABS. T. W. Armstrong and S. K. Penny (Oak Ridge National Lab., Tenn.). Oct. 2, 1964. Contract W-7405-eng-26. 16p. Dep.(mn); $1.00 (cy), 1(mn) OTS.

The Monte Carlo Code OGREISH-P1 was written to perform the computation of gamma-ray transmission through laminated infinite slabs. The code is essentially a modernization of the TRIGR-P code in that the importance sampling techniques are similar and the code is written in FORTRAN in a modern Monte Carlo system called OGRE. (auth)

1815 (RRA-M44) REFLECTION OF THERMAL NEUTRONS AND NEUTRON-CAPTURE GAMMA RAYS FROM CONCRETE. M. B. Wells (Radiation Research Associates, Inc., Fort Worth, Tex.). June 12, 1964. For Oak Ridge National Lab., Tenn. Contract W-7405-eng-26, Subcontract 2267. 33p. (CONF-446-40) Dep. (mn); $2.00(cy), 1(mn) OTS.

From American Nuclear Society 10th Annual Meeting Philadelphia, June 1964.

Monte Carlo methods were used to compute thermal-neutron and thermal-neutron capture-gamma differential albedos for TSF and Portland concretes. The results obtained for the thermal-neutron differential albedo for Portland concrete were fitted by the equation $0.21 \cos^{\frac{1}{2}}\theta_0 \cos\theta$, where θ_0 and θ are the angles of incidence and reflection, respectively. The total thermal-neutron flux reflected per unit incident flux was found to be given by $0.414\ \pi\cos\theta_0$ for TSF concrete and $0.42\ \pi\cos^{\frac{1}{2}}\theta_0$ for Portland concrete. The Monte Carlo calculations of the capture-gamma dose reflected from concrete per unit incident thermal-neutron flux were fitted by the expression $1.046 \times 10^{-5} \cos^{\frac{1}{2}}\theta_0 \cos^{\frac{1}{2}}\theta$ for TSF concrete and by the expression $6.986 \times 10^{-6} \cos\theta_0 \cos\theta$ for Portland concrete. The units of the albedos are erg g^{-1} hr^{-1} steradian^{-1} per unit incident thermal-neutron flux. The Monte Carlo calculations of the total thermal-neutron reflection from both TSF and Portland concretes were found to be in reasonably good agreement with albedo expressions derived by both Fermi and Halpern, et al. Calculations of the thermal-neutron capture-gamma dose rates inside 4-ft diameter concrete-lined cylindrical holes dug in the ground at the Oak Ridge National Laboratory Tower Shielding Facility show, when compared with measured data, that the major component of the gamma dose rate in the holes is that resulting from thermal-neutron capture in the concrete walls. (auth)

1816 (TID-21196) MEASUREMENT OF GAMMA-RAY ABSORPTION COEFFICIENTS IN THE 5-11 Mev RANGE (thesis). Karl Duane Tremba (Pennsylvania State Univ., University Park). Sept. 1962. 79p. Dep.(mn); $3.00(cy), 2(mn) OTS.

The purpose of the research was to determine the feasibility of accurately measuring gamma ray absorption coefficients using the (n,γ) reaction as a source of monochromatic gamma rays. The apparatus was examined for possible sources of systematic errors such as double and single scattering processes and degradation of energy. Mathematical corrections were developed for the effects of degraded energy and single scattering. Double scattering effects were negligible. The absorption coefficients in copper and aluminum at 7.7 Mev were measured as $0.03041 \pm 0.25\%$ cm^2/gm and $0.02423 \pm 0.5\%$ cm^2/gm, respectively. The largest contribution to the uncertainty of these measurements arose from statistical fluctuations in the measurements of the beam intensity and from random errors in the "half-max" method of analysis used. Errors due to statistical fluctuations could have been reduced by making more determinations of the transmission ratio (φ_0/φ_x). Errors from the "half-max" type of analysis could have been diminished by locating the window more accurately than to the nearest tenth of a channel. Considerable error was introduced in the absorption coefficient for aluminum when it was corrected for impurities. This source of error could have been greatly reduced by using an absorber better than 99.5% aluminum or by obtaining a quantitative analysis of the impurities in the sample used to greater precision than was afforded by spectrochemical analysis. Considerable error was also introduced because of the great uncertainty in the intensity and energy distribution of the degraded energy in the beam. It is recommended that more investigation, both theoretical and experimental, be conducted to accurately determine the degraded energy spectrum. It was concluded, that the use of (n,γ) reaction gamma rays in the 5 to 11 Mev range for measuring absorption coefficients was practical. An accuracy of better than 0.5% was attained in the determinations of μ_m. It was possible to mathematically correct for systematic errors introduced by the apparatus. (auth)

1817 (UNC-5086) MINIMUM WEIGHT SHIELD SYNTHESIS FOR SPACE VEHICLES. F. R. Nakache, A. D. Krumbein, J. Celnik, and J. Certaine (United Nuclear

Corp. Development Div., White Plains, N. Y.). May 20, 1964. Contract NAS-8-5277. 133p.

The proton shield synthesis technique for spherical geometry was extended to include a number of dose constraints and analytic expressions derived to calculate doses behind given spherical shields in particular proton environments. The theory of shield optimization for generalized convex enclosures was likewise extended and calculations carried out that give shield compositions and layer thicknesses over a wide range of parameters. The secondary neutron portion of the optimization theory was also extended to include new materials and more complex shields. (auth)

1818 DOSE BUILD-UP FACTORS FOR CONCRETE. A. Hoenig (Brno Technical Univ.). Kerntechnik, 6: 393-9 (Sept. 1964). (In German)

The different attenuations of narrow and broad radiation beams are discussed. The build-up factors for photon flux density, energy flux density, energy absorption, and exposure rate are introduced and expressed as sums of exponential functions. Calculated build-up factors for the exposure rate are demonstrated in diagrams and detailed tables, relative to concrete with a density of 2.35 t/m^3. The necessary shielding thicknesses were determined by means of numerical examples and also by use of the Frieseke & Hoepfner Radiation Protection Slide Rule. (auth)

1819 NEUTRON SHIELD. (to Goodyear Tire and Rubber Co.). German Patent 1,167,459. Apr. 9, 1964. Priority date May 27, 1959, United States.

A neutron shield was constructed of neutron-absorbing particles distributed in an organic binding agent. The shield consists of a fill of small particles of polyethylene or a material with similar hydrogen density and a filler of the organic binding agent filling up the cavities of the fill. (Gmelin Inst.)

REACTOR TECHNOLOGY

General

1820 (CONF-446-42) THE EVALUATION AND MEASUREMENT OF REACTOR SAFETY PERFORMANCE. H. J. Larson and K. Stratton (General Electric Co. Atomic Power Equipment Dept., Pleasanton, Calif.). June 5, 1964. Contract AT(04-3)-189. 32p. Dep.(mn); $2.00(cy), 1(mn) OTS.

From American Nuclear Society 10th Annual Meeting, Philadelphia, June 1964.

The tightly integrated auditing system developed at Vallecitos for surveillance of reactor operations and to evaluate reactor safety performance is described. The system has been applied to GETR, VBWR, ESADA–VESR, and the Radioactive Materials Laboratory. (R.E.U.)

1821 HEAT TRANSFER IN NUCLEAR REACTORS. B. F. Gromov and A. S. Trofimov. Inzh. Fiz. Zh., 7: No. 8, 31-6(Aug. 1964). (In Russian)

The equations are given for defining temperatures of the coolant and multi-layer fuel element of a reactor. An analytical solution is obtained for the arbitrary laws of a change in heat release and coolant temperature at the reactor inlet if the coolant flow rate does not change. (auth)

1822 [BREAK-UP OF A REACTOR]. G. Garrington. Nucl. Energy, 296-8(Oct. 1964).

Fragment size distributions from a reactor breakup due to implosion or explosion are discussed. (C.E.S.)

1823 PROCEEDINGS OF THE TENTH ANNIVERSARY CONFERENCE, NOVEMBER 18-21, 1963, NEW YORK CITY. AtomForum 1963. A Decade of Progress. A FORUM Report. Robert N. Ubell, ed. (Atomic Industrial Forum, Inc., New York). 1964. 178p. $7.50.

Separate abstracts were prepared for ten sections of the conference. (D.C.W.)

For abstracts of individual sections see: 713, 855, 1857, 1916, 1917, 1918, 1919, 1920, 1931, and 1932.

Auxiliaries and Components

Refer also to abstract 752.

1824 (CEA-R-2537) IRRADIATIONS DE L'AMBIANTE A 2000°C DANS LES PILES PISCINE. (Irradiations in Swimming-Pool-Type Reactors From Room Temperature Up to 2000°C). J. Berger, A. Briand, M. de Cachard, D. Gros, P. Millies, and J. Perrin (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Grenoble). 1964. 38p. Dep.(mn).

Irradiation cells and loops for use in Melusine and Siloe are described. Controlled atmospheres and temperatures from room to 2000°C are possible. (R.E.U.)

1825 (IITRI-578P22-11) STUDIES OF REACTOR CONTAINMENT STRUCTURES. Bi-Monthly Progress Report No. 8262-10. R. L. Chiapetta and M. A. Salmon (Illinois Inst. of Tech., Chicago. IIT Research Inst.). Sept. 1964. Contract AT(11-1)-578. 38p. Dep.(mn); $2.00(cy), 1(mn) OTS.

The design and development of reactor containment structures are studied. A solution to the problem of a spherical cap with a reinforced circular opening loaded by static internal pressure is presented. The hole is symmetrically located at the apex of the spherical cap and the base edge of the cap is clamped. The solution is valid for large plastic deformations of the cap. An approximate elastic-plastic analysis was completed for a thin, infinite, flat plate containing an unreinforced circular hole and loaded by in-plane tensile stresses applied at infinity in a given biaxiality ratio. The solution is valid only for small deformations. Tests on flat circular plates with centrally-located, reinforced, circular holes included bulge tests without openings and tests of plates with a central boss simulating rigid reinforcement. The effect of plate thickness, hole size, type of reinforcement, and amount of reinforcement are evaluated for plates loaded by static lateral pressure. (N.W.R.)

1826 (TDVI-40) AN EXPERIMENTAL STUDY OF THE MASS DISCHARGE OF HIGH-ENTHALPY WATER FROM PIPES UNDER CONDITIONS OF THERMAL GRADIENTS. P. Vilim (Atomic Energy of Canada Ltd. Nuclear Power Plant Div., Toronto). June 1962. Reprinted May 1964. 39p. (AECL-1926). Dep.; $1.00 (AECL).

Experiments were conducted to measure the discharge rate of hot water from a simulated complete circumferential weld fracture in a cold reactor header. The discharge experiments were carried out through different tapered nozzle configurations, and the results are compared with calculations based on Morison's method. The results indicate that Morison's method is adequate, that a circumferential weld failure is the worst type of pipe failure, and that a peak mass discharge rate of 93 lb/sec-in.^{2} is possible from the failure. (D.L.C.)

1827 REVOLVING TARGET HOLDER FOR IRRADIATION IN REACTOR. Lajos Varkonyi and Ferenc Krebsz. Magy. Tud. Akad. Kozp. Fiz. Kut. Int. Kozlemen., 12: 313-16(1964). (In Hungarian)

A revolving target holder is described. The device was developed to eliminate possible errors induced by the difference in dose rates absorbed by samples irradiated simultaneously in the same target holder. This fact was observed when evaluating results of radiation chemical experiments. (auth)

1828 NONSTATIONARY TEMPERATURE FIELD OF FROZEN SECTIONS IN SYSTEMS WITH LIQUID-METAL COOLANTS. P. I. Bystrov. Teplofiz. Vysokikh Temp., 2: 429-36(1964).

An analytical solution was obtained which permits determination of the nonsteady-state temperature field in the center and at the boundaries of frozen sections of pipings in nuclear power stations using liquid metal as the coolant. Freezing of the coolant can be used for sealing of liquid-metal systems. In nuclear power stations with liquid-metal cooling, some sections of the loops can be frozen, which makes it possible to exchange separate loop elements and to perform preventive maintenance without draining the coolant from the pipes and the reactor. Knowledge of the temperature fields in the frozen section permits accurate selection of the type of coolant, the intensity of heat removal, and the dimensions of this section. The freezing time is of great importance for evaluating the effectiveness of the frozen section. Nomograms are given for determining the dimensionless temperature in the center and at the boundaries of the frozen section as a function of Biot and Fourier numbers. The dimensionless temperature was plotted versus the pipe length for a flow of sodium (1073°K) cooled with air (293°K) for 1380 sec in a pipe 0.2 m in diameter. (OTS)

1829 ELASTIC, ELECTRICALLY CONDUCTING DEVICE FOR THE SUSPENSION AND THE FEEDING OF A HOLDING MAGNET FOR NUCLEAR CONTROL RODS. Victor Jean Gerard and Jean Antoine Martin (to Groupement Atomique Alsacienne Atlantique). German Patent 1,168,576. Apr. 23, 1964. Priority date June 15, 1961, France.

The device consists of two helical springs with a u-shaped cross section and opposite hand, which are fastened together by a ring arranged between the two opposing ends of the springs. The upper end of the upper spring is connected to a connection box located at the top of the control

rod housing and the lower end of the lower spring is connected to the magnet. (Gmelin Inst.)

1830 A MOVABLE DEVICE FOR THE RECEPTION, STORAGE AND DISPOSITION OF RADIOACTIVE RODS. René Guilloteau and Vsevolod Dachkevitch (to Commissariat à l'Energie Atomique). German Patent 1,169,046. Apr. 30, 1964. Priority date Aug. 14, 1959, France.

A device that enables the rods to be dried and has a protective cap that can be moved from the receiving position to the depositing position is described. A thin-walled basket is provided for receiving the rods arranged within the protective cap and is capable of a vertical displacement relative to the cap. Opposing openings are provided in the upper region of the protective cap and the basket for the introduction of the rods, and in the lower region for the withdrawal of the rods. The lower opening of the cap enables passage of the basket. The device is also provided with a ducting system carrying a gas and connecting the inside of the basket with an absorption system for the moisture in the gas that has surrounded the rods. (Gmelin Inst.)

1831 AN OBSERVATION WINDOW PROVIDED WITH REFLECTION MIRRORS FOR NUCLEAR REACTION CHAMBERS. Guy Baudiffier (to Europaische Atomgemeinschaft). German Patent 1,169,597. May 6, 1964. Priority date Mar. 2, 1961, Belgium.

In order to achieve improved shielding for the optical system and for the operator, a rotatable drum made of shielding material with diametrically opposed observation windows and two light beam channels originating from one window and terminating at the other window was designed. The outer and inner walls of the channels carry reflection mirrors connected to the drum. The drum is incorporated in a replaceable block of the cell wall with the drum axis being horizontally arranged in the wall plane and the light beam channels extending rhombically around the drum shaft. The chambers between the outer reflection mirrors and the outer edge of the drum on the one hand and the chamber between the inner reflection mirrors and the drum shaft on the other hand are filled with a shielding material. This arrangement enables the operator to replace mirrors without radiation hazards while still maintaining a substantial field of observation. (Gmelin Inst.)

1832 SOLID MODERATOR STACK FOR NUCLEAR REACTORS. Georges Lemesle, Roger Manès, and Pierre Rougé (to Commissariat à l'Energie Atomique). U. S. Patent 3,152,965. Oct. 13, 1964. Priority date Nov. 20, 1961, France.

Improvements were made in the design of elements that effect a coupling between various rods in the construction of stacks of solid moderator rods. Identical prismatic rods with lateral faces provided successively with a rib and then a groove by which coupling with adjacent rods is effected are used. The ribs and grooves are formed in such a manner that in each rod the distance between the longitudinal axis of the rod and the bottom of each groove is equal to the distance between the longitudinal axis and the base of each rib. (M.C.G.)

Criticality Studies

Refer also to abstracts 758, 1909, and 1915.

1833 (AEEW-M-447) MEASUREMENTS OF Pu-239: U-235 FISSION RATIO USING FOILS AT TEMPERATURES UP TO 390°C. D. H. Carter, B. J. Puckett, and A. E. Richards (United Kingdom Atomic Energy Authority. Reactor Group. Atomic Energy Establishment, Winfrith, Dorset, England). May 1964. 23p. Dep.; $0.80(BIS), 4s. (HMSO).

The use of activation foils for the measurement of $^{239}Pu-to-^{235}U$ fission ratios in subcritical lattices at temperatures up to 390°C is described. Counting techniques and the method of analysis of the results are described in detail and the results are compared with fission chamber measurements. (auth)

1834 (AEEW-R-318) BUCKLING AND REACTION RATE EXPERIMENTS IN PLUTONIUM/URANIUM METAL FUELLED, GRAPHITE MODERATED LATTICES AT TEMPERATURES UP TO 400°C. PART I. EXPERIMENTAL TECHNIQUES AND RESULTS. D. H. Carter, R. Hobday, B. J. Puckett, W. G. Clarke, C. Hunt, C. R. Symons, M. Gibson, J. Marshall, and T. Wass (United Kingdom Atomic Energy Authority. Reactor Group. Atomic Energy Establishment, Winfrith, Dorset, England). July 1964. 138p. Dep.; $4.20(BIS), 21s.(HMSO).

The report presents experimental measurements of bucklings, flux fine structure, and fission rate distributions in graphite-moderated lattices fueled with plutonium/uranium metal at temperatures up to 400°C in the subcritical assemblies SCORPIO I and SCORPIO II. The experimental techniques employed are described in some detail. The accuracy of the experimental measurements appears to be adequate for testing methods of calculation being developed for the calculation of reactivity and temperature coefficient of reactivity for power reactors containing plutonium and uranium. (auth)

1835 (AEEW-R-354) THULE: A DETAILED DESCRIPTION. M. J. Terry (United Kingdom Atomic Energy Authority. Reactor Group. Atomic Energy Establishment, Winfrith, Dorset, England). July 1964. 46p. Dep.; $1.20 (BIS), 6s.(HMSO).

The THULE scheme of lattice physics calculation, which was developed in FORTRAN for the IBM 7090, is described. The scheme predicts the neutron flux over energy and space, for many groups and regions, together with reactivity and reaction rate edits for both a single lattice cell and a reactor core. The report describes in detail the input requirements for the THULE program, which forms the main part of the scheme. Brief descriptions of the 7090 programs TED 6 and NOAH are included. TED 6 will produce the THULE edits from a WDSN output tape and NOAH is a version of the METHUSELAH program, which contains many of the THULE edits and will also produce input cards for THULE. (auth)

1836 (AEEW-R-389) DATA PREPARATION FOR THE COMPUTER CODE FLIRT. M. E. R. Veale and H. E. Wrigley (United Kingdom Atomic Energy Authority. Reactor Group. Atomic Energy Establishment, Winfrith, Dorset, England). Aug. 1964. 32p. Dep.; $0.90(BIS), 4s.6d. (HMSO).

The report describes the data preparation for the FORTRAN one-dimensional reactor transient program FLIRT, and the method of operation of the program. It includes examples of both input and output for a typical transient calculation. It also includes a section on the numerical techniques used to increase the speed of solution. See NSA 18: 27842 for original program. (auth)

1837 (DP-894) LASS—AN IBM 704 PROGRAM FOR CALCULATING SYSTEM STABILITY. S. M. Katz and D. S. St. John (Du Pont de Nemours (E.I.) & Co. Savannah River Lab., Aiken, S. C.). July 1964. Contract AT-(07-2)-1. 129p. Dep.; $4.00(cy), 1(mn) OTS.

The LASS (Linear Analysis of System Stability) code is an IBM 704 program to compute the stability and transient response of dynamic systems. Up to 50 system equations (in up to 50 system variables) are written in linearized form (for example, by assuming small perturbations about a steady-state operating condition). After taking Laplace transforms, a system of linear, algebraic equations is obtained in which the coefficients are polynomials in the Laplace transform variable, s. The LASS code accepts the matrix of these coefficient polynomials, reduces it to a single transfer function (ratio of polynomials in s), and calculates and plots the stability characteristics, frequency response, and transient response of the system. A sample problem from a nuclear reactor system was used to illustrate the use of the code. The system contained nine equations and system variables, three parameters (power level and two reactivity coefficients), and one input excitation. The 130-page output contained the transient response of two of the system variables to impulse, step,

and ramp inputs for each of five power levels. The total running time on the IBM 704 was 40 minutes. (auth)

1838 (HW-82400(p.5.1-10)) PHYSICS ASPECTS OF PLUTONIUM FUELS. F. G. Dawson (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

A discussion is presented of the nuclear properties of Pu, of the reactor physics problems of Pu utilization in thermal reactors, and of Hanford's plutonium physics program. The nuclear properties of Pu are compared with those of ^{235}U. The experimental, theoretical, and theory-experiment correlation studies in the plutonium physics program are reviewed, and some data are tabulated. The effects of uncertainties in physics parameters on fuel cycle costs and other reactor characteristics are discussed. (D.L.C.)

1839 (NAA-SR-7892) THERMAL NEUTRON SPECTRUM EFFECTS ON CALCULATIONS FOR GRAPHITE LATTICES. F. L. Fillmore (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Oct. 15, 1964. Contract AT(11-1)-Gen-8. 27p. Dep.; $2.00(cy), 1(mn) OTS.

The effect of the thermal neutron spectrum on the multiplication constant in calculations for graphite-moderated lattices is examined. The point in question is not the theory of calculating the spectrum but rather how to employ spectrum results once they are obtained. The procedure for utilizing experimental flux measurements is also examined, and formulas are developed consistent with those of a commonly employed flux-averaging procedure for lattices using theoretical flux results. The average neutron velocity for each region of the lattice cell appears explicitly in these formulas. Results of calculations are given for 6 lattice spacings for a typical uranium-graphite lattice. Flux measurements are avilable for 3 of these spacings. Two essentially different calculational methods are employed. One of these uses the same neutron spectrum in all regions of the lattice cell while the other uses a different spectrum in each region. The latter method gives a harder spectrum in the fuel than in the moderator. Comparison of reactivity differences between these methods shows that taking into account the spectral hardening in the fuel reduces the calculated reactivity by nearly 2 percent for the close lattice spacings. This difference would be greater for blacker fuel elements such as those employed in typical sodium-graphite reactors. The need for an accurate treatment of the thermal neutron spectrum is demonstrated. In particular, it is important to take into account the additional spectral hardening in the fuel relative to that in the moderator. The free-gas graphite scattering kernel with an effective carbon mass that is dependent on the graphite temperature, and perhaps on the lattice spacing, is adequate for this spectral hardening. (auth)

1840 (NAA-SR-Memo-5397) TRANSIENT ENERGY RELEASE ANALYSIS OF AN EXPERIMENTAL FUEL PIN IN TREAT. J. R. Hume (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). June 21, 1960. Contract AT-11-1-GEN-8. 17p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The time- and space-dependent energy release in an experimental fuel pin placed in the Transient Reactor Test Facility (TREAT) was analyzed. The problem is essentially the determination of the time and space neutron flux, which is, of course, proportional to the heat generation rate. A simplification results from the assumption of a "stationary" spatial flux that is established during steady state and persists while the reactor is experiencing a transient. Calculation of the stationary flux determines the relation between energy released in the fuel pin and energy released in the TREAT core. Then the time-dependent fuel pin and energy release problem is completed if the time dependent and integral energy release of the TREAT core can be computed or determined experimentally. The numerical results reported here are normalized to an integral energy release of 1000 Mw-sec in the whole TREAT core. Users of the data can make suitable adjustments to match the time dependent and integral energy release of a particular transient. (auth)

1841 PROKAI–A CODE FOR ANISOTROPIC DIFFUSION IN THERMAL REACTORS WITH HOLLOW TUBE FUEL ELEMENTS. V. Pierpaoli and L. Sartori (SNAM, Milan). Energia Nucl. (Milan), 11: 543-56(Oct. 1964).

A program for the calculation of the diffusion coefficients in thermal reactors with hollow-tube fuel elements is described. The code is written for the ELEA 6001 computer. A comparison is given with the standard homogenization methods. An extensive set of curves, which permits evaluating the diffusion coefficients without using the program, is also given. (auth)

1842 REACTIVITY MEASUREMENTS BY WAY OF PULSE SOURCE MEASUREMENTS. H. Kraemer (Kernforschungsanlage, Julich, Ger.). Kerntechnik, 6: 400-3 (Sept. 1964). (In German)

Pulse-source measurements gain increasing importance for the measurement of reactivities. The principles of this measuring process are presented in the simplest form possible. The application of the process and its performance, as well as the design of the measuring device, are described in detail. (auth)

1843 INVESTIGATION OF FISSION AND ABSORPTION PROCESSES IN THE RANGE OF EPITHERMAL NEUTRON ENERGIES FOR HETEROGENEOUS URANIUM WATER REACTORS. Peter Vertes and Laszlo M. Kovacs. Magy. Tud. Akad. Kozp. Fiz. Kut. Int. Kozlemen., 12: 263-85(1964). (In Hungarian)

For fission and adsorption processes in the range of epithermal neutron energies, the resonance fission as well as the internal and external lumping effects of 1/v absorption are considered. Though the calculations presented here, owing to errors in the nuclear data which have been used, are of an estimative character, the results indicate the major importance of the fission processes during slowing down for maintaining the chain reaction in thermal reactors. (auth)

1844 THE EFFECT OF A FOREIGN ELEMENT OR RIG IN A REFLECTED REACTOR. T. C. Chawia (Univ. of New South Wales, Kensington, Australia). Nucl. Energy, 284-93(Oct. 1964).

In conventional research type nuclear reactors composed of heterogeneous or homogeneous combinations of fissionable and moderating materials, the experimental rigs and control rods are inserted in the reactor, and when they are removed from their position leave behind holes in the reactor. In the region of a hole or a rig inserted into the hole the flux distribution is greatly affected, and any analysis for the reactor system is incomplete if the presence of the hole or rig is not taken into account. The mathematical analysis of an eccentric hole in an infinite cylindrical reflected reactor is developed. (C.E.S.)

1845 A SPACE-DEPENDENT DYNAMIC ANALYSES OF BOILING WATER REACTOR SYSTEMS. Amir N. Nahavandi and Richard F. von Hollen (Westinghouse Electric Corp., Pittsburgh). Nucl. Sci. Eng., 20: 392-413(Dec. 1964).

A one-dimensional space-dependent dynamic analysis of boiling water reactors, for direct, indirect, or dual-cycle systems with forced or natural circulation, is presented. The analytical model consists of space-dependent neutron-kinetics equations for the reactor core, and flow-conservation equations for the reactor coolant system developed in terms of length along the flow path and time. The resulting set of non-linear partial differential equations is expressed spatially in finite-difference form and integrated numerically in time to obtain the space- and time-dependent system variables. The effect of system-pressure variation is neglected. The mathematical model and numerical procedures employed in this study are verified against test data from an experimental boiling loop. Analytical predictions of the threshold of instability and the frequency of oscillations are shown to be in agreement with the test data. Studies of the uncontrolled and controlled behavior of a 110-Mw(e) direct-cycle boiling water nuclear power station confirm that, in contrast with natural-circulation loops, forced-circulation boiling systems have a high degree of hydrodynamic stability. However, an inappropriate

selection of control-system parameters may induce nuclear power instability in both natural- and forced-circulation plants. The theoretical approach presented may be successfully employed for the determination of the system stability, as well as for evaluation of the degree of effectiveness and relative merits of various system power-control techniques. (auth)

1846 THERMAL-NEUTRON SPACE-TIME DECAY CONSTANTS IN VARIOUS ORDER P_n APPROXIMATIONS. A. Travelli and Gerald P. Calame (Rensselaer Polytechnic Inst., Troy, N. Y.). Nucl. Sci. Eng., 20: 414-27(Dec. 1964). (TID-19521)

The thermal neutron space-time eigenvalue spectrum of the multigroup P_N approximation is investigated numerically for a modified form of the Radkowsky kernel. Both discrete eigenvalues and eigenvalues that are assigned to a "continuum region," on the grounds that the corresponding eigenvectors exhibit singularities, are found. The continuum region so defined agrees well with that expected for the Boltzmann equation. It is found that, when λ, the time decay constant, is plotted vs B^2, the square of the geometrical buckling, there is in the P_N approximation a critical value B^2_{max} beyond which no real eigenvalues λ exist. The value of B^2_{max} is sensitive to the order of the P_N approximation, increasing with increasing N. It is conjectured that B^2_{max} corresponds, when the extrapolated endpoint is considered, to a slab of zero thickness through which a burst of neutrons would pass undisturbed as an ideal traveling wave. (auth)

1847 TIME-DEPENDENT FLUX IN SMALL ASSEMBLIES. F. D. Judge and P. B. Daitch (Rensselaer Polytechnic Inst., Troy, N. Y.). Nucl. Sci. Eng., 20: 428-35(Dec. 1964). (TID-20202)

The one-dimensional (slab), one velocity, time-dependent transport equation has been investigated using a variational method employing flat spatial trial functions. A simple approximation is found for the variation of the asymptotic decay rate (α) with slab size for small slabs. As expected, little difference is found between the use of a single flat spatial flux trial function and double stepped flux trial function for thin slabs. The method is extended to the case of a convex body of arbitrary shape. For the slab case, an effective spatial buckling and an effective extrapolation distance consistent with the exact asymptotic decay constant were obtained. This extrapolation distance is approximately equal to the Milne-problem value down to a scattering thickness of about 1.0 mean free path, after which it rises to λ_t for the limiting case of zero thickness. Finally, asymptotic time decay rates based upon low-order P_L and DP_L approximations in slab geometry are determined either numerically or from the exact analytical solutions; a real eigenvalue may or may not exist depending on the boundary conditions. It is shown further that these low-order approximations yield erroneous time-dependent characteristics in the thin slab limit. (auth)

1848 TIME-DEPENDENT VARIATIONAL PRINCIPLES FOR NONCONSERVATIVE SYSTEMS. Jeffrey Lewins (Royal Engineers, Glasgow). Nucl. Sci. Eng., 20: 517-20 (Dec. 1964).

Two variational principles are discussed for time-dependent problems in reactor physics. The first is a stationary expression for the meter reading at a given time, the second a stationary expression for the integral of the meter reading up to a given time. Both the principles, unlike conventional Lagrangians extended to time-dependent nonconservative systems, have the advantage of requiring trial functions to be exact only at one end of the time interval of interest. Either may be generalized to account for nonlinearities. The second principle reduces to the first by making a suitable identification, while the first principle in turn reduces to a well-known and powerful variational principle for the steady state. (auth)

1849 REACTOR PHYSICS. Nucleonics, 22: No. 10, 112-13(Oct. 1964).

A summary is given of Geneva Conference papers on calculational techniques for criticality prediction, flux and power distribution, control predictions, and fuel burnup. (C.E.S.)

1850 CRITICAL CONDITION FOR INHOMOGENEOUS REACTOR WITH RODS OF FINITE RADIUS. Roman Bednarz (Inst. for Nuclear Research, Warsaw) and Borus P. Kochurov. Nukleonika, 9: 439-50(1964). (In Russian)

A large heterogeneous reactor with a lattice of cylindrical fuel rods separated by more than a few mean free paths is considered. There is no slowing down of neutrons in the fuel rods and the moderator absorption is small. The fuel rod is characterized by two polarizability coefficients for slowed down neutrons as well as for thermal ones. Critical condition was derived from the age theory approximation for slowed down neutrons. (auth)

1851 CRITICAL REACTOR WITH A NON-LINEAR BOND BETWEEN NEUTRON FLUX AND TEMPERATURE IN MULTIGROUP APPROXIMATION. O. B. Moskalev. Zh. Vychislitel. Mit. i Mat. Fiz., 4: 599-604(May-June 1964). (In Russian)

The critical operation of a reactor for monoenergetic neutrons is extended to the case where the neutron distribution in the reactor is described by a set of multigroup equations, and the neutron transport of each group is given by the equation of Peierls. The reactor has a convex shape, and consists of an arbitrary number of regions, each of which is characterized by its own neutron reaction cross section. One of the arguments of the various cross sections used in the formulas is the temperature, which in turn depends on the point at which the cross section itself is being calculated. It is assumed that the temperature is determined only by the thermal neutron flux, that is, thermal reactors only are considered. The existence and uniqueness of a positive solution to the problem is proved. On assuming that the cross section decreases monotonically with increasing temperature and flux, it is still possible to select a linear operator that gives a unique positive solution. (TTT)

Design and Feasibility

1852 FAST REACTORS. LARGE EXPERIMENTAL AND COMPUTING EFFORT REQUIRED FOR FURTHER DEVELOPMENT. A. M. Judd. Elec. Rev., [175:] 56-8 (July 10, 1964).

Some kinetics, critical mass, neutron physics, and shielding calculations (primarily for the Dounreay Fast Reactor) are discussed, together with associated experimental efforts. (D.C.W.)

Fuels

Refer also to abstract 1872.

1853 (GEAP-4621) ACCURATE NUCLEAR FUEL BURNUP ANALYSES. Tenth Quarterly Progress Report, March–May 1964. B. F. Rider, J. P. Peterson, Jr., C. P. Ruiz, and F. R. Smith (General Electric Co. Vallecitos Atomic Lab., San Jose, Calif.). June 1, 1964. Contract AT(04-3)-189. 30p. Dep.(mn); $2.00(cy), 1(mn) OTS.

In the development of accurate methods for determination of nuclear fuel burnup mass spectrometric analysis of stable fission product isotopes is being studied as a means to improve accuracy. One of the most promising of such isotopes is ^{148}Nd. During this quarter, an attempt was made to resolve some of the uncertainties in the use of this isotope as a total fission burnup indicator. The thermal neutron cross section of ^{148}Nd was found to be 2.43 ± 0.19 barns. The ^{148}Nd resonance integral, Σ, above the cutoff of 0.43 ev for a 20-mil Cd filter (including the 1/v portion) was determined to be 16.7 ± 2.3 barns. These values were calculated from the radioactivity of ^{149}Nd formed on neutron activation. The half-life of the ^{149}Nd was found to be 1.72 ± 0.02 hr. A new decay scheme for ^{149}Nd with levels at 114, 211, 269, 537, and 650 kev

is proposed to explain γ-λ coincidence data on the higher intensity gamma rays. The ^{149}Nd 650-kev absolute gamma-ray intensity which has not been previously reported in the literature was found to be (7.8 ± 1.4)% of the disintegration rate. (auth)

1854 (HW-82400(p.7.1-5)) PLUTONIUM-FUELED REACTOR OPERATING EXPERIENCE. W. D. Richmond (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

The operation of the PRTR with Pu-bearing fuels is reviewed with respect to possible use of Pu in other reactors. Fuel storage and handling, transients, control systems, reactor safety mechanisms, fuel element failures, training requirements, and procedural controls are discussed. It is believed that power reactors presently using U fuel could use Pu enrichment without paying a significant cost premium for equipment modifications or more involved operating procedures. (D.L.C.)

1855 (HW-83577) ZODIAC2 USER'S MANUAL. D. D. Matsumoto and G. J. Busselman (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Oct. 1, 1964. Contract AT(45-1)-1350. 62p. Dep.(mn); $3.00(cy), 2(mn) OTS.

The ZODIAC2 code is a multigroup, multiregion burnup code for the IBM 7090. It is a combination of slightly modified existing programs and specialized linkage routines, designed to do survey-type burnup analysis of nuclear reactor fuel. The group cross sections are formed by the TEMPEST and GAM codes; the group fluxes and the reactivity are found by HFN; and the isotope transmutations are carried out by ALCHEMY. Unique features include recalculation of microscopic cross sections at each burnup time step, multiregion burnup, and complete flexibility concerning the spectrum of the reactor and the isotopes to be burned. A brief statement of the function and methods of each code in ZODIAC2 is given and preparation of input is fully described. After initial familiarization with the reference documentation, the normal utilization of the code should not require further reference to any other document. The code described by the report is in an advanced stage of checkout and may therefore be used with a reasonable degree of confidence. Areas of uncertain performance are noted. (auth)

1856 MEASUREMENT OF FREE FISSION-GAS PRESSURE IN OPERATING UO_2-FILLED FUEL RODS. Myron B. Reynolds (General Electric Co., Pleasanton, Calif.). Nucl. Sci. Eng., 20: 386-91(Dec. 1964).

A differential-type pressure transducer suitable for use in a fast-neutron environment at elevated temperatures has been developed. The sensitivity of this device is approximately 0.25 lb/in.^{2} with the ability to withstand an unbalance pressure of over 1500 lb/in.^{2} from either direction. A number of stainless-steel-clad, UO_2-filled fuel rods equipped with these transducers have been irradiated in the Vallecitos Boiling Water Reactor to exposures up to roughly 4000 Mwd/t peak. These experiments have shown that fission-gas release is negligible from UO_2 operated below the recrystallization temperature. For operation at higher temperatures, observed fission-gas pressures were in quantative agreement with measured void volume and quantity of free gas found in post-irradiation examination. The decrease in void volume during operation has been calculated for a fuel rod and the calculated value used to estimate a mean fuel temperature. (auth)

1857 PRIVATE OWNERSHIP AND THE FUEL CYCLE. p.145-56 of "Proceedings of the Tenth Anniversary Conference of the Atomic Industrial Forum." New York, Atomic Industrial Forum, 1964.

Fuel reprocessing and reactor economics and technology under conditions of private fuel ownership and toll enrichment are discussed, together with the prospects for private fuel ownership and plutonium economics and technology in a private fuel market. (D.C.W.)

1858 I COMBUSTIBILI NUCLEARI. (Nuclear Fuels). Bologna, Licinio Cappelli, 1963. 140p. L. 500.

The steps in the production of nuclear fuels including geochemical prospecting for ores, evaluation of the ore deposits, mining, production of uranium concentrates, production of metallic uranium, and fabrication of the fuel elements are summarized. The principal methods used in each of these steps are described. (J.S.R.)

1859 NUCLEAR FUEL ELEMENT UNIT. Stanley Hackney (to United Kingdom Atomic Energy Authority). German Patent 1,167,458. Apr. 9, 1964. Filed May 16, 1960.

Elongated fuel elements are detachably joined in parallel by a coupling device, which consists of holding plates provided with projections and recesses and coupled together by a ring-shaped connecting member with two sets of corresponding projections and recesses. Means are provided for avoiding the rotation of the connecting member. An essential feature of the invention is that the distance between the ends of the fuel members is greatly reduced with respect to a bayonet joint. (Gmelin Inst.)

1860 FUEL ELEMENTS FOR NUCLEAR REACTORS. Andrew T. Bowden and John M. Robertson (to C. A. Parsons and Co. Ltd.). U. S. Patent 3,152,963. Oct. 13, 1964. Priority date Jan. 26, 1956, Great Britain.

A fuel element was designed so that the load on the fuel containers and the nuclear fuel housed therein is substantially reduced. The design is applicable in graphite-moderated reactors. The fuel element consists of a container housing nuclear fuel and a graphite tube surrounding the container adapted to support another container located immediately above it. Spaces are provided between the tube and container for coolant flow. The outer surface of the graphite tube has protruding shoulders at each end of the container, which is finned. The fins are interrupted at a plurality of points by spaced baffle plates each of which extends for the axial length of the container and in a radial direction beyond the fins. (M.C.G.)

1861 FUEL CARTRIDGES FOR NUCLEAR REACTORS. Maurice Avramito and René Cébélieu (to Commissariat à l'Energie Atomique). U. S. Patent 3,152,964. Priority date June 5, 1958, France.

A fuel cartridge for use in reactors where all the fuel present in a channel is inserted or removed at the same time was designed to improve the utilization of the thermal exchange surface of the cans. The perimeter of the cross section of the can of at least one cartridge varies according to the location of the cross section along the length of the can so that the temperature of the can remains, at any point, close to the maximum permissible temperature, during operation of the reactor. The can consists of a casing the outer wall of which is inscribed in a body of revolution, which consists of two coaxial conic frustums having a common large base and extending from it in opposite directions. The wall is provided with longitudinal corrugations consisting of ribs and grooves. (M.C.G.)

Power and Power-Breeder Reactors

1862 (AECL-2073) SAFETY FEATURES OF NPD AND THEIR PERFORMANCE. Guest Hake (Atomic Energy of Canada Ltd. Chalk River Nuclear Labs., Chalk River, Ont.). Sept. 1964. 6p. (CONF-766-1). Dep.; $0.20(AECL).

From 10th AECL Symposium on Atomic Power, Chalk River, Ont., Oct. 1964.

Safety features of NPD providing for both minor malfunctions and the "maximum credible accident" are described. (R.E.U.)

1863 (AEEW-R-374) SPECTRUM MEASUREMENTS IN THE ZENITH PLUTONIUM CORE 7 USING A NEUTRON CHOPPER. F. R. Barclay, I. R. Cameron, H. H. W. Pitcher, and C. R. Symons (United Kingdom Atomic Energy Authority. Reactor Group. Atomic Energy Establishment, Winfrith, Dorset, England). May 1964. 34p. Dep.; $1.00(BIS), 5s.(HMSO).

The core of ZENITH for the first plutonium loading is described. A neutron chopper was used to study the beam

emerging from the core; theoretical and experimental results are compared. (R.E.U.)

1864 (ANL-6838) DOPPLER EFFECT MEASUREMENTS, SODIUM VOID COEFFICIENTS, AND CRITICAL STUDIES OF A 5,000-LITER FAST POWER BREEDER REACTOR BY THE TWO-ZONE METHOD. ZPR-III Assembly 43. J. M. Gasidlo, J. K. Long, and W. P. Keeney (Argonne National Lab., Idaho Falls, Idaho). May 1964. Contract W-31-109-eng-38. 40p. Dep.; $2.00(cy), 1(mn) OTS.

Assembly 43 is the second two-zone core built in the ZPR-III facility. The central zone and the low-density axial blanket were designed to simulate a large power-breeder reactor. Criticality was achieved by an annular driver, while an interposed buffer modified the spectrum of the neutrons diffusing from the driver to the central zone. Experiments included sodium void coefficients for central substitutions and for full-length axial measurements. Other reactivity measurements included central reactivity coefficients and core-length column substitutions in the central zone and the annular driver. Spectral indices were measured, and reaction-rate traverses and activation experiments were performed. The reactivity change due to the Doppler effect caused by heating a large, depleted, uranium oxide sample was also determined in the experimental program. The experimental results indicate that the measurements can be used for checking calculations of dilute fast cores, as well as evaluating the two-zone experimental technique. (auth)

1865 (ANL-6921) DESIGN AND PERFORMANCE CHARACTERISTICS OF EBR-II CONTROL ROD DRIVE MECHANISMS. E. Hutter and G. Giorgis (Argonne National Lab., Ill.). Aug. 1964. Contract W-31-109-eng-38. 34p. Dep.; $2.00(cy), 1(mn) OTS.

The design and performance of the drive mechanisms for the EBR-II control rods are described. Identical drive mechanisms are provided for each of the 12 control rods. (R.E.U.)

1866 (APAE-Memo-201) SPECIFICATIONS AND FABRICATION PROCEDURES FOR PM-2A STATIONARY FUEL ELEMENTS. (Alco Products, Inc., Schenectady, N. Y.). June 11, 1959. Contract DA-30-347-eng-284. 117p.

Stainless steel-base fuel components of thin plate-type construction and containing a dispersion of UO_2 have been successfully employed in powering the Army Package Power Reactor (SM-1). The component is designed for radioactive service in pressurized water and consists of eighteen composite fuel plates joined into an integral unit or assembly by brazing. Specifications covering loading, materials, and processing are presented. A list of applicable drawings and the process flow diagram are included. (auth)

1867 (APAE-Memo-202) SPECIFICATIONS AND FABRICATION PROCEDURES FOR PM-2A CONTROL ROD FUEL ELEMENTS. (Alco Products, Inc., Schenectady, N. Y.). June 11, 1959. Contract DA-30-347-eng-284. 111p.

Stainless steel-base fuel components of thin plate-type construction and containing a dispersion of UO_2 have been successfully employed in powering the Army Package Power Reactor. The component is designed for radioactive service in pressurized water and consists of sixteen composite fuel plates joined into an integral unit or assembly by brazing. Specifications covering loading, materials, and processing are presented. A list of applicable drawings and the process flow diagram are included. (auth)

1868 (APAE-Memo-203) SPECIFICATIONS AND FABRICATION PROCEDURES FOR PM-2A NEUTRON ABSORBER SECTIONS. (Alco Products, Inc., Schenectady, N. Y.). June 11, 1959. Contract DA-30-347-eng-284. 67p.

The control rod absorber section consists of composite plates joined by welding to form a rectangular parallelepiped. The composite plates consist of compacts of europium oxide in a stainless steel matrix that are clad with stainless steel by hot roll-bonding. These specifications cover materials and process required to produce the absorber section. The procedural specifications are specific for manufacturing these components at ORNL, and represent a detailed guide for fabricators. (auth)

1869 (APDA-146) CONCEPTUAL DESIGN OF A 300-Mwe PASTE-FUELED FAST BREEDER POWER REACTOR. (Atomic Power Development Associates, Inc., Detroit). Oct. 1961. 107p.

The conceptual design of a 300-Mw(e) fast breeder reactor power plant that utilizes a paste-fuel system consisting of small, spherical particles settled in sodium is described. Both the core and blanket material in this reactor are mobile, moving continuously through the reactor at a low velocity. The core and blanket are shell-and-tube type structures with paste flow on the shell side. Sodium flowing through the tubes transports the heat out of the reactor to a secondary sodium system. Steam, produced in a sodium-water steam generator, drives a conventional turbine. The basic reactor design, performance and cost data are given. A major portion of the report is devoted to a discussion of the paste-fuel system, which is a unique feature of the reactor concept. The design of the core and blanket structure is discussed, and a detailed analysis of the design is given. Included is a description of a fuel-handling system that provides for circulating the paste, filling and draining the core and blanket, supplying fresh fuel to the reactor, and bleeding off fuel for reprocessing. Processes for fabricating and processing the fuel particles are described, and the nuclear characteristics of a paste-fuel system are considered, with particular reference to the conceptual design. Novel concepts that were used in the design for the operating and safety control systems, the reactor vessel, the primary heat transport system, and the shielding are also covered. These innovations were incorporated into the design on the basis that they are desirable to preserve the full advantages of the mobile-fueled system. (auth)

1870 (BW-67-2(Vol.1)) SODIUM-HEATED STEAM GENERATOR DEVELOPMENT. VOLUME 1. GENERAL. Preliminary Design Report [of the] Full Size Steam Generator. (Babcock and Wilcox Co., Barberton, Ohio). July 1, 1964. Contract AT(11-1)-1280. 183p. Dep.(mn); $5.00(cy), 3(mn) OTS.

The report is the Design Report on the Preliminary Design of the Full-Size Steam Generator. The Full-Size Steam Generator is of a size that three steam generators will produce steam to drive a 1000-Mw(e) turbine. The report is divided into two major parts. In Volume 1 is a description of the plant steam cycle, the heat transfer data at full and part load, a description of the steam generators, and reduced size copies of some of the arrangement drawings. In Volume 2 are summarized the results of the ASME Code calculation, the steady-state stress analysis, and the transient temperature and stress analysis. A sample calculation showing a typical steady-state and transient analysis is included to illustrate the method of solution. (auth)

1871 (BW-67-2(Vol.2)) SODIUM-HEATED STEAM GENERATOR DEVELOPMENT. VOL. 2. STRESS ANALYSIS. Preliminary Design Report. (Babcock and Wilcox Co. Barberton, Ohio). July 1, 1964. Contract AT(11-1)-1280. 130p. Dep.(mn); $4.00(cy), 3(mn) OTS.

1872 (CONF-446-41) SODIUM LOGGING BEHAVIOR OF FAST CERAMIC REACTOR FUELS. G. L. O'Neill, P. E. Novak, and M. L. Johnson (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). [1963]. Contract AT(04-3)-189. 20p. Dep.(mn); $1.00(cy), 1(mn) OTS.

From American Nuclear Society 10th Annual Meeting, Philadelphia, June 1964.

The steady-state and startup transient behavior of oxide fuels operating in a power reactor after sodium has accidentially entered a defective fuel rod was investigated in an experimental capsule irradiation program. Test conditions included purposely thinned clad, "transient" irradia-

tion to 125 per cent of peak FCR power conditions at over 200 times the expected load-following rate, and the incorporation of "captured" sodium that was purposely exposed to maximum temperatures expected within an operating fuel element. The lack of fuel damage in these tests indicates that power levels for oxide fuels which result in values of 90 to 100 w/cm may be realized without fear of damaging effects from sodium-logging phenomena. Restating, the central temperature of high-density uranium oxide and mixed PuO_2 fuels may be raised to, or even slightly above, the melting point without fear that the accidental ingress of sodium into fuel will produce damaging sodium vapor pressures. A test conducted to investigate the effect of power cycling resulted in the only observed cladding deformation. The purposely-defected fuel rod was cycled 100 times to peak FCR power conditions (48 w/cm, 680°C clad temperature). The observed slight clad deformation evidently occurred primarily because of fuel-clad interaction; however, comparable cycling of nondefective fuel rods would be required to establish whether sodium contributed to the deformation. In all tests conducted, the increased thermal conductivity in the fuel rod due to the presence of sodium resulted in markedly cooler center temperature, thus, effectively reducing the threatened high sodium vapor pressure. The bonding of oxide fuel elements with sodium appears to be a reasonable alternate fuel design which merits further study. (auth)

1873 (CVNA-215) MONTHLY OPERATING REPORT [ON CVTR OPERATION], SEPTEMBER 1964. (Carolinas Virginia Nuclear Power Associates, Inc., Parr, S. C.). 33p. Dep.(mn); $2.00(cy), 1(mn) OTS.

The CVTR was operated at essentially full licensed power (44.3 MW gross thermal). The generator was on the line for 498.78 hours and the gross electrical generation was 4,820,000 kwh. The reactor was intentionally shutdown on two occasions due to operational difficulties with the heavy water recovery dryer in the vapor container and once due to indication of a primary coolant leak from the failed fuel element detection and location system. Major maintenance efforts were expended during the shutdown period to make the necessary repairs to equipment in the vapor container and permit reactor operation to continue. Three reactor scrams occurred during the last part of the month. Heavy and light water systems chemistry remained generally within specifications. Fluorides in the moderator heavy water were believed to be due to peroxides. Special health physics coverage was provided for all shutdown work within the vapor container. The South Carolina Electric & Gas Company began and completed a part of the revisions necessary to provide more reliable sources of power for the reactor plant. (auth)

1874 (DP-925) HEAVY WATER MODERATED POWER REACTORS PROGRESS REPORT, JULY–AUGUST 1964. R. R. Hood, comp. (Du Pont de Nemours (E.I.) & Co. Savannah River Lab., Aiken, S. C.). Sept. 1964. Contract AT(07-2)-1. 48p. Dep.; $2.00(cy), 1(mn) OTS.

The Heavy Water Components Test Reactor (HWCTR) was operated intermittently for fuel irradiation tests. Severe pitting attack of the carbon steel tubes of the steam generators resulted from temporary inadequate removal of oxygen from the feedwater to the generators. The feedwater control and treatment were modified to eliminate further rapid attack of the tubes. Physics calculations indicate that the removal of a single fuel assembly from an operating D_2O-cooled reactor would cause flux peaks of less than 5% in adjacent fuel positions at lattice pitches of practical interest. Fabrication was started on driver fuel assemblies of uranium oxide for the HWCTR. Design parameters were formulated for use in design studies of a 1000-Mw(e) D_2O-cooled-and-moderated reactor. Kinetic studies of the 1000-Mw(e) reactor indicate that the turbine and reactor systems can be controlled and protected by normal control design. (auth)

1875 (EURAEC-1011) AN ADVANCED RESEARCH PROGRAM ON THE APPLICATION OF STEAM–WATER SPRAY TO THE COOLING OF LIGHT WATER REACTORS. CAN 2 Final Report, July 1, 1961–February 29, 1964. (Centro Informazioni Studi Esperienze, Milan). Mar. 31, 1964. Work Performed under United States–Euratom Joint Research and Development Program. Contract 060-61-7-RDI. 59p. (CISE-R-112). Dep.(mn); $3.00(cy), 2(mn) OTS.

A steam-water mixture was studied as coolant for nuclear reactors. The work concerned extensive heat transfer and hydrodynamic measurements, corrosion and erosion tests under aggravated conditions. A large number of experimental data were collected and analyzed from theoretical point of view. (auth)

1876 (GA-4413) THE PHYSICS CHARACTERISTICS OF THE EXPERIMENTAL BERYLLIUM OXIDE REACTOR. A. D. McWhirter and A. J. Goodjohn (General Atomic Div. General Dynamics Corp., San Diego, Calif.). Oct. 24, 1963. Contract AT(04-3)-187. 159p. Dep.(mn); $5.00(cy), 3(mn) OTS.

Results of calculations made in the Experimental Beryllium Oxide Reactor (EBOR) nuclear design effort are reported. The calculations support the loading chosen, demonstrate the adequacy of the control rods, show that the design lifetime requirements are met, and give details of the power and flux distribution. A discussion of the comparison between the results of experiments and calculations for the EBOR critical experiment is also given, inasmuch as it applies to the EBOR calculations. Calculations on emergency shutdown conditions — flooding the core with a cadmium solution and mechanically removing the reflector — are given. (auth)

1877 (GAMD-2251) CONSTRUCTION OF HANFORD TEST ELEMENT, MGCR-HDR-3. W. L. Wyman (General Atomic Div. General Dynamics Corp., San Diego, Calif.). May 11, 1961. Contract AT(04-3)-187. 46p. Dep.(mn); $2.00(cy), 1(mn) OTS.

Fabrication and results of non-nuclear tests of the MGCR-HDR-3 Hanford loop element are reported. The element is a modified version of the MGCR-BORE fuel element concept and is designed to test this concept under reactor operating conditions. The element is made up of eighteen fuel bearing pins composed of BeO-enriched UO_2 pellets encased in 0.010-inch wall Hastelloy-X tubes; the center pin was a Hastelloy-X tube containing BeO pellets. (R.E.U.)

1878 (GAMD-3611) THE DEVELOPMENT AND IRRADIATION OF A 19-ROD-BUNDLE FUEL ELEMENT. H. C. Hopkins, Jr., and B. E. Kott (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Oct. 30, 1962. Contract AT(04-3)-187. 56p. Dep.(mn); $3.00(cy), 1(mn) OTS.

A 19-rod-bundle fuel element (MGCR-HDR-3) was irradiated for 5705 hours at surface temperatures of 1500 and 1700°F. The experiment demonstrated that the element design and fabrication made it capable of performing satisfactorily at EBOR conditions. An extensive prepile test program and post-irradiation examination were carried out. The fuel rods consist of Hastelloy-X cladding for BeO–UO_2 fuel pellets. (auth)

1879 (GEAP-4356) PHYSICS SPECIFICATIONS FOR SENN ON-LINE COMPUTER PRELIMINARY REPORT. N. H. Barth (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). July 1964. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(04-3)-189. 43p. (EURAEC-1212) Dep.(mn); $2.00(cy), 1(mn) OTS.

Calculations to be performed on-line at the SENN Garigliano plant are reviewed; automatic solution of the reactor critical wave equation is considered. (R.E.U.)

1880 (IDO-28634) ARMY GAS-COOLED REACTOR SYSTEMS PROGRAM. FINAL REPORT. FULL POWER AND LIMITED ENDURANCE TEST OF THE ML-1 NUCLEAR POWER PLANT (ANSOP 16625A). (Aerojet-General Nucleonics, San Ramon, Calif.). Sept. 1964. Contract AT(10-1)-880. 181p. Dep.; $5.00(cy), 4(mn) OTS.

The results of performance analyses of the ML-1 nuclear

power plant based on the test data obtained during ANSOP 16625A, "The ML-1 Full Power and Limited Endurance Test" are presented. The test was accomplished during the period of 13 April through 29 May 1964 at the National Reactor Testing Station in Idaho. During this period, the reactor operated for 1493.35 Mw-hr at an average power of about 2.2 Mw(t), and 823.28 hr of turbine-compressor set rotation were logged, including 664.55 hr at self-sustained conditions. All major objectives of the test were achieved. Analysis of the performance data demonstrated a significant advance in the development of the power plant. A number of startup and shutdown transients were experienced during the test but no major problems developed. The primary performance deficiency observed is associated with the turbine-compressor set; the maximum measured net power of 139 kw is considerably less than the 234 kw predicted for corresponding operating conditions. The mechanical and neutronic performance of the reactor was essentially as predicted. The analyses of the effectiveness of the reactor shielding indicated that this critical part of the plant performed as designed. The performance of other components was generally acceptable and very similar to that experienced in earlier testing. The overall power output of the plant was less than predicted, primarily because of the poorer than anticipated performance of the turbine-compressor set. (auth)

1881 (LA-DC-6608) CONTROL ELEMENT DRIVE MECHANISMS FOR LAMPRE I. Rolf E. Peterson (Los Alamos Scientific Lab., N. Mex.). [nd]. Contract W-7405-eng-36. 23p. (CONF-756-1). Dep.(mn); $1.00(cy), 1(mn) OTS.

From Meeting of Fast Reactor Control Rod Drives, Germantown, Md., Sept. 1964.

The use of hydraulically powered reactor control-rod drive systems may, in some applications, offer certain advantages over the more conventional control element actuators. The paper deals with an instance in which such a rod drive system was successfully utilized on an experimental reactor. (auth)

1882 (NAA-SR-9777(Vol.I)) FINAL EVALUATION REPORT — HALLAM NUCLEAR POWER FACILITY. VOLUME I. J. E. Price, comp. and ed. (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Sept. 29, 1964. Contract AT(11-1)-Gen-8. 227p. Dep.(mn); $6.00(cy), 4(mn) OTS.

A description of the plant is given, and testing and operation of its components are discussed. Separate evaluation reports are included for the main heat transfer system, the sodium service system, the cooling water system, the reactor loading face shield cooling system, and the helium system. The report is one of six volumes. (R.E.U.)

1883 (NAA-SR-9777(Vol.II)) FINAL EVALUATION REPORT — HALLAM NUCLEAR POWER FACILITY. VOLUME II. J. E. Price and J. W. Rocke, eds. (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). June 12, 1964. Contract AT(11-1)-Gen-8. 375p. Dep.(mn); $7.00(cy), 6(mn) OTS.

Separate evaluation reports are presented for the nitrogen system, radioactive vent system, radioactive liquid waste system, auxiliary steam system, preheating system, instrument air system, emergency power system, nuclear instrumentation system, and plant control system. (R.E.U.)

1884 (NAA-SR-9777(Vol.III)) FINAL EVALUATION REPORT — HALLAM NUCLEAR POWER FACILITY. VOLUME III. J. E. Price and J. W. Rocke, eds. (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). June 12, 1964. Contract AT(11-1)-Gen-8. 341p. Dep.(mn); $7.00(cy), 6(mn) OTS.

Separate evaluation reports are presented for the plant protective system, radiation detection and monitoring system, lighting, power, and communication system, wash cells, portable purge unit, decontamination room, maintenance cell, control rod drive and actuator assemblies, control rod actuator support structure, control rod operability, neutron chamber cart, drives, and cables, purge of the secondary sodium system, purge of the primary sodium system and reactor vessel with helium, sodium leak detection system, temperature instrumentation using thermocouple elements, dry criticality, initial fill of sodium secondary system, and initial fill of sodium primary system. (R.E.U.)

1885 (NAA-SR-9777(Vol.IV)) FINAL EVALUATION REPORT — HALLAM NUCLEAR POWER FACILITY. VOLUME IV. J. E. Price and J. W. Rocke, eds. (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). June 12, 1964. Contract AT(11-1)-Gen-8. 334p. Dep.(mn); $7.00(cy), 5(mn) OTS.

Separate evaluation reports are presented for wet-critical tests, sodium level instrumentation, sodium flow instrumentation, sodium pressure instrumentation, dry excess loading, reactor heaters, protective system modification for fuel loading, and hot sodium circulation. (R.E.U.)

1886 (NAA-SR-9777(Vol.V)) FINAL EVALUATION REPORT — HALLAM NUCLEAR POWER FACILITY. VOLUME V. J. E. Price and J. W. Rocke, eds. (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). June 12, 1964. Contract AT(11-1)-Gen-8. 282p. Dep.(mn); $.600(cy), 5(mn) OTS.

Separate evaluation reports are presented for the hydraulic test of the main heat transfer system, heat transfer tests, steam generator–steam purity, cooling system, plant protective system, plant control system, emergency feedwater system, scram and loss-of-load, and radiation shielding. (R.E.U.)

1887 (NAA-SR-9777(Vol.VI)) FINAL EVALUATION REPORT — HALLAM NUCLEAR POWER FACILITY. VOLUME VI. J. E. Price and J. W. Rocke, eds. (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). June 12, 1964. Contract AT(11-1)-Gen-8. 333p. Dep.(mn); $7.00(cy), 5(mn) OTS.

Separate evaluation reports are presented for wet excess fuel loading, axial power distributions, control rod calibration, zero-power coefficient of reactivity, power coefficient, radial power distribution and fuel channel orifice adjustment, the master schedule including rise-to-power, and xenon poisoning. (R.E.U.)

1888 (NAA-SR-9799) HALLAM NUCLEAR POWER FACILITY. REACTOR OPERATIONS ANALYSIS PROGRAM. Semiannual Progress Report No. 3, September 1, 1963–February 29, 1964. D. K. Darley, O. G. Jenkins, C. L. Larson, et al. (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Sept. 15, 1964. Contract AT(11-1)-Gen-8. 148p. Dep.; $5.00(cy), 3(mn) OTS.

From September 1, 1963 through February 29, 1964, the HNPF was on the line 2836.8 hr, generating 85,756,000 kwh of electrical energy for an accumulated total of 119,913,000 kwh. Significant events during this period were: The Zircaloy control rod thimbles were replaced by stainless steel thimbles. The core loading was enlarged by addition of ten UC fuel elements. Control rod atmosphere helium purification system was installed. Difficulties were encountered in adjusting fuel channel orifices. Shift in flux from the east to northwest portion of the core attributed to a failed moderator can. Other events are also analyzed. Fuel element burnup and reactivity are analyzed. Systems and component analysis is also discussed. (N.W.R.)

1889 (NP-14365(Pt.B)) APPLICATION TO THE UNITED STATES ATOMIC ENERGY COMMISSION FOR CONSTRUCTION PERMIT AND OPERATING LICENSE. OYSTER CREEK NUCLEAR POWER PLANT UNIT NO. 1. Preliminary Safeguards Summary Report. (Jersey Central Power and Light Co., Morristown, N. J.). Mar. 1964. 226p. (DOCKET-59-219). Dep.(mn); $6.00(cy), 5(mn) OTS.

The reactor site and its environs, preliminary design and operating features of the proposed unit, and a preliminary analysis of the project from the standpoint of safety are discussed. (R.E.U.)

1890 (SL-2158) LARGE CONDENSING AND NON-CONDENSING TURBINE PLANT STUDY. (Sargent and Lundy, Chicago). June 30, 1964. For Oak Ridge National Lab., Tenn. Contract [W-7405-eng-26], Subcontract 2148. 36p. Dep.(mn); $2.00(cy), 1(mn) OTS.

Costs and performance characteristics of three large turbine generator plants, two of which are designed for exhausting steam to a desalination plant and the third is a conventional condensing unit, are discussed. Each of the units is rated nominally at 650 Mw(e), and will be used in large dual-purpose reactor power plants. (R.E.U.)

1891 (TID-21129) TITLE I AND TITLE II—DESIGN AND ENGINEERING. Annual Report, March 1963–June 1964. (Connecticut Yankee Atomic Power Co., Haddam). Aug. 1964. Contract AT(30-1)-3250. 68p.

Design and development of the Connecticut Yankee plant is progressing on schedule even though many modifications are being made. Information is included on: site development, structural features, reactor design, coolant system, auxiliary systems, safety and engineered safeguards, turbine, electrical equipment, and plant design characteristics. (N.W.R.)

1892 (TID-21231) HALLAM NUCLEAR POWER FACILITY MONTHLY OPERATING REPORT NO. 25, AUGUST 1964. (Consumers Public Power District, Hallam, Nebr.). Contract AT(11-1)-513. 73p. Dep.(mn); $3.00(cy), 2(mn) OTS.

The operation and performance of the Hallam power reactor are summarized. Information is included on: core performance, sodium purity, control rod thimble helium atmosphere, sodium oxide scrubber test, primary cell leak test, radiation control, maintenance, modifications, control, and power output. (N.W.R.)

1893 (TID-21251) MEASUREMENT OF HBWR-II CORE PARAMETERS IN THE NORA REACTOR. K. Bryhn-Ingebrigtsen, N. L. Snidow, A. Myking, and H. Smidt Olsen (Norway. Institutt for Atomenergi, Kjeller). Aug. 1964. Contract [AT(30-1)-2607]. 29p. (KR-70; NORA-8). Dep.(mn); $2.00(cy), 1(mn) OTS.

Some experimental results for NORA in-pile tests of enriched fuel clusters for the second loading of the Halden Boiling Water Reactor are presented. Measurements were made of thermal-neutron flux distributions, moderator level coefficient of reactivity, core importance function, flux depression by an SS thimble, and void effects. (R.E.U.)

1894 (WAPD-TM-433) METALLURGICAL EXAMINATION OF PWR CORE-1 BLANKET FUEL RODS AT THE END OF THE THIRD SEED LIFE. L. R. Lynam (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Aug. 1964. Contract AT(11-1)-Gen-14. 22p. Dep.; $1.00(cy), 1(mn) OTS.

The examination has been completed for two rods that were removed from PWR Core 1 at the end of the third seed life of operation. After having attained an average rod exposure of 6.4×10^{20} fissions/cc, no significant dimensional or microstructural changes have occurred in the fuel or clad. Fission gas release values are low and consistent with test elements irradiated to equivalent exposures. (auth)

1895 (JPRS-26808) TEN YEARS OF THE WORLD'S FIRST ATOMIC ELECTRIC POWER STATION IN THE USSR. Translation of "10 Let Pervoy v Mire Atomnoy Elektrostantsii SSR," (a publication of Atomizdat, Moscow, 1964). 184p. (TT-64-51065) $5.00(OTS).

The experience gained during ten years of operation of the First Atomic Electric Power Station in the U.S.S.R. is outlined. The experimental possibilities of the reactor, the operation of the process channels, calculation of the recharging conditions, calculation of the isotopic composition of the fuel, calculation of temperature conditions of the fuel elements, the steam generators, the operation of uncooled absorption rods, tests of pre-loop conditions, a high-pressure water loop for testing fuel elements, irradiation of materials in the reactor, effects of gamma radiation on the electric conductivity of water, sources of contamination of the heat-transfer agent and its purification, kinetics of the oxidation of irradiated reactor graphite, and neutronographic investigations in the reactor are discussed. Separate abstracts are prepared for each of the 15 papers presented. (C.E.S.)

For abstracts of individual papers see: 437, 971, 1008, 1896, 1897, 1898, 1899, 1900, 1901, 1902, 1903, 1904, 1905, 1906, and 1907.

1896 (JPRS-26808(p.2-13)) SOME RESULTS OF THE OPERATION OF THE FIRST ATOMIC ELECTRIC POWER STATION (AES). G. N. Ushakov and L. A. Kochetkov. Translated from p.5-19 of "10 Let Pervoy v Mire Atomnoy Elektrostantsii SSR."

Operation of the process channels and mechanical equipment, the conditions of the water, the temperature and gaseous conditions of the graphite stacking, radiation safety, and measurements of reactivity, power, heat transfer, thermal neutron flux distributions, and poisoning are discussed. (C.E.S.)

1897 (JPRS-26808(p.14-26)) EXPERIMENTAL POSSIBILITIES OF THE REACTOR AES. L. A. Kochetkov and G. N. Ushakov. Translated from p.20-34 of "10 Let Pervoy v Mire Atomnoy Elektrostantsii SSR."

A description of the arrangement of several experimental loops and the conditions of their operation is given. The single-circuit superheated steam loop, the two-circuit superheated steam loop, the water loop with natural circulation, and the water loop for chemical investigation are discussed. (C.E.S.)

1898 (JPRS-26808(p.27-38)) EXPERIENCE IN OPERATION OF THE PROCESS CHANNELS. G. N. Ushakov, L. A. Kochetkov, V. G. Konochkin, and V. S. Sever'yanov. Translated from p.35-47 of "10 Let Pervoy v Mire Atomnoy Elektrostantsii SSR."

The characteristics of the process channels and fuel elements and operation of the channel under conditions of boiling, superheating of the steam, and natural circulation are discussed. (C.E.S.)

1899 (JPRS-26808(p.39-47)) CALCULATION OF THE RECHARGING CONDITIONS OF THE PROCESS CHANNELS. V. N. Sharapov. Translated from p.48-57 of "10 Let Pervoy v Mire Atomnoy Elektrostantsii SSR."

Calculations for determining the distribution of thermal neutron flux and heat release on the radius of the reactor during continuous replacement of burned-up channels are presented. (C.E.S.)

1900 (JPRS-26808(p.48-57)) CALCULATION OF THE ISOTOPIC COMPOSITION OF THE FUEL IN THE FUEL ELEMENTS OF THE REACTOR. V. N. Sharapov. Translated from p.58-67 of "10 Let Pervoy v Mire Atomnoy Electrostantsii SSR."

The relative concentration of ^{235}U, ^{236}U, ^{238}U, ^{239}Pu, ^{240}Pu, and ^{241}Pu in the fuel was calculated as a function of the burnup fraction of ^{235}U and compared with experimental determinations. (C.E.S.)

1901 (JPRS-26808(p.58-73)) CALCULATION OF THE TEMPERATURE CONDITIONS OF A TUBULAR FUEL ELEMENT. V. Ya. Kozlov. Translated from p.68-84 of "10 Let Pervoy v Mire Atomnoy Elektrostantsii SSR."

The method of constructing nomograms for calculation of the temperature of fuel elements is examined. (C.E.S.)

1902 (JPRS-26808(p.74-85)) FROM EXPERIENCE IN THE OPERATION OF STEAM GENERATORS. G. N. Ushakov, L. A. Kochetkov, V. B. Lytkin, V. V. Popov, N. T. Belinskaya, and A. F. Sokolov. Translated from p.85-98 of "10 Let Pervoy v Mire Atomnoy Elektrostantsii SSR."

The welding of the main elements of the steam generator, monitoring and testing its elements, the operating conditions of the steam generator, the water conditions, and accidents that occurred during operation are described. (C.E.S.)

1903 (JPRS-26808(p.86-91)) PROBLEMS IN THE OPERATION OF UNCOOLED ABSORPTION RODS. G. N. Ushakov, L. A. Kochetkov, V. G. Konochkin, and V. S.

Sever'yanov. Translated from p.99-109 of "10 Let Pervoy v Mire Atomnoy Elektrostantsii SSR."

Experimental investigations of the practical possibilities of using uncooled absorption rods in the reactor are described. The work was directed toward creating heat-resistant absorption rods with a working temperature up to 1000°C and with a compensating capacity equal to that of rods of boron carbide. Boron steel was selected as the material for the rods. (C.E.S.)

1904 (JPRS-26808(p.92-111)) TESTS OF PRE-LOOP CONDITIONS. V. V. Dolgov and O. A. Sudnitsyn. Translated from p.107-30 of "10 Let Pervoy v Mire Atomnoy Elektrostantsii SSR."

Pre-loop experiments were conducted to determine the stability of the fuel elements and materials of the reactor under given conditions of cooling and to determine the best methods and conditions of cooling fuel elements of a given type in stationary and transient conditions. (C.E.S.)

1905 (JPRS-26808(p.112-18)) A HIGH-PRESSURE WATER LOOP FOR TESTING FUEL ELEMENTS. G. N. Ushakov, L. A. Kochetkov, V. G. Konochkin, and V. Ya. Kozlov. Translated from p.131-8 of "10 Let Pervoy v Mire Atomnoy Elektrostantsii SSR."

A description of the high-pressure water loop installed in the reactor for tests of fuel elements of different designs, for the investigation of high burnup of fuel compositions, and for studies of materials is presented. (C.E.S.)

1906 (JPRS-26808(p.119-31)) IRRADIATION OF MATERIALS IN THE REACTOR. G. N. Ushakov and L. A. Kochetkov. Translated from p.139-55 of "10 Let Pervoy v Mire Atomnoy Elektrostantsii SSR."

A description is given of the four cylindrical horizontal materials-study channels for production of artificial radioisotopes and the study of the effects on neutron radiation on various materials. (C.E.S.)

1907 (JPRS-26808(p.140-56)) SOURCES OF CONTAMINATION OF THE HEAT-TRANSFER AGENT AND ITS PURIFICATION. P. N. Slyusarev, V. A. Ivanov, and A. G. Karabash. Translated from p.166-84 of "10 Let Pervoy v Mire Atomnoy Elektrostantsii SSR."

Results of investigations connected with the study of sources and the chemical nature of contaminations of the distilled water coolant in the primary circuit of the AES and with its purification are presented. (C.E.S.)

1908 DESIGN PARAMETERS FOR 500 Mw CANDU REACTOR. I. L. Wilson (Atomic Energy of Canada Ltd., [Chalk River,] Ont.), C. E. Beynon, W. G. Morison, and N. L. Williams. Can. Nucl. Technol., 3: No. 4, 38-42 (1964).

The fuel bundles, moderator system, turbine-generator, instrumentation, control, and containment of the 500 Mw CANDU reactor are discussed. Cost estimates are also given. (C.E.S.)

1909 A MEASUREMENT OF THE FINE STRUCTURE DISTRIBUTION OF THE THERMAL FLUX IN ORGANIC COOLED FUEL ELEMENTS IN A D_2O MODERATED LATTICE. A. Boeuf and S. Tassan (CCR EURATOM, Ispra, Italy). Energia Nucl. (Milan), 11: 533-42(Oct. 1964).

The fine structure distribution of the thermal flux in single-rod fuel elements and ECO critical facility clustered fuel elements, of various geometries and using different organic coolants (i.e. monoisopropyl-diphenyl and diphyl) has been measured by activation of disprosium detectors using both integral and differential techniques. The differential data for the rods of the clustered element have been interpreted in terms of simple analytical expressions, in agreement with the integral data. (auth)

1910 PRESENT STATE OF ORGANIC REACTORS. Istvan Szentgyoergyi. Energie Atomtech., 17: 331-44(July 1964). (In Hungarian)

In principle, aromatic hydrocarbons are excellent moderating media and have been considered for use in power reactors for some time. The first such reactor, OMRE, was built in 1957 to establish the feasibility of this concept. In view of the very satisfactory results obtained, design studies have been undertaken in several countries and some of the reactors are already under construction. The systems reviewed include both the organic-cooled-and-moderated and the organic-cooled, heavy-water-moderated reactors. The fouling caused by the organic medium at the surface of the fuel elements reduces the efficiency of the system. The U. S. organic-cooled program was somewhat reduced in view of this experience but the Euratom and the Soviet programs continue at the original level. The organic systems present the advantages of low boiling point, minor corrosion problems, slight induced radioactivity, and excellent chemical compatibility with the fuel elements. The disadvantages include the decomposition and polymerization of the organic liquids exposed to radiation, poor heat-transfer characteristics, increased heating requirements, and the need for external heating because of the high melting point of the materials considered. At present diphenyl and terphenyl and their mixtures are studied most seriously. The danger presented by flammability or explosion of the organic liquid is very slight. As the result of the intensive development studies, the investment costs keep decreasing. The investment cost of the 300 Mwe OMCR is estimated at $170/kw, while the energy generation costs are expected to reach only 6.39 mills/kwh. In the case of the Canadian OCDR reactor the generating costs are expected to be even more favorable. (TTT)

1911 THE ÅGESTA REACTOR. [II]. B. McHugh. Nucl. Energy, 280-3(Oct. 1964).

A description is given of the gas system, fuel element failure detection and emergency cooling system, waste treatment, and refuelling methods for the Agesta Reactor. (C.E.S.)

1912 INTEGRATING NUCLEAR POWER INTO NATIONAL GRIDS. Nucleonics, 22: No. 10, 58-63(Oct. 1964).

A summary is given of the Geneva Conference Papers that outline plans for nuclear power development in the U. S., Argentina, Australia, Canada, Portugal, Russia, and Spain. (C.E.S.)

1913 POWER-PLANT OPERATING EXPERIENCE. Nucleonics, 22: No. 10, 64-71(Oct. 1964).

A summary is given of the Geneva Conference papers on the operating experience of boiling-water reactors, pressurized-water reactors, gas-cooled reactors, and heavy-water reactors. (C.E.S.)

1914 ADVANCED REACTOR CONCEPTS. Nucleonics, 22: No. 10, 74-9(Oct. 1964).

A summary is given of the Geneva Conference papers on advanced reactor designs and concepts including nuclear superheat projects, fast-breeder reactors, heavy-water reactors. Applications such as water desalination and nuclear space power units are also discussed. (C.E.S.)

1915 REACTOR SAFETY. Nucleonics, 22: No. 10, 87-92(Oct. 1964).

A summary is given of Geneva Conference papers on reactor safety system reliability, fission product behavior, and excursion studies. (C.E.S.)

1916 NUCLEAR APPLICATIONS TO SALINE WATER CONVERSION. ECONOMIC IMPLICATIONS. A PANEL DISCUSSION. p.1-16 of "Proceedings of the Tenth Anniversary Conference of the Atomic Industrial Forum." New York, Atomic Industrial Forum, 1964.

The results of studies on the economics of nuclear desalination plants, particularly plants also producing electricity, are summarized, together with associated technological efforts. Cost estimates are given, including comparisons of conventional and nuclear systems. (D.C.W.)

1917 GOVERNMENT PARTICIPATION IN ATOMIC POWER DEVELOPMENT. A PANEL DISCUSSION. p.36-54 of "Proceedings of the Tenth Anniversary Conference of the Atomic Industrial Forum." New York, Atomic Industrial Forum, 1964.

The role of government in nuclear power development is discussed. (D.C.W.)

1918 REACTOR SAFETY TESTING PROGRAM. NEEDS AND PLANS. p.55-71 of "Proceedings of the

Tenth Anniversary Conference of the Atomic Industrial Forum." New York, Atomic Industrial Forum, 1964.

Reactor safety activities related to civilian power reactors are outlined; and the status of the safety program at ORNL and of the LOFT and SPERT programs is summarized, together with research on the control of iodine. The relation of test reactor experience to power reactor operations is also considered. (D.C.W.)

1919 ATOMIC POWER DEVELOPMENT IN THE SOVIET UNION. A SPECIAL ADDRESS. p.116-19 of "Proceedings of the Tenth Anniversary Conference of the Atomic Industrial Forum." New York, Atomic Industrial Forum, 1964.

The development of nuclear power in the USSR is discussed, with consideration of power demands and sources. Reactor research and development is outlined, together with construction of nuclear power plants. The power plant of the nuclear icebreaker Lenin is briefly considered, together with operation of the vessel for four years. (D.C.W.)

1920 INTERNATIONAL POLICIES AND DEVELOPMENTS. p.157-69 of "Proceedings of the Tenth Anniversary Conference of the Atomic Industrial Forum." New York, Atomic Industrial Forum, 1964.

International industrial cooperation in nuclear power development is discussed. The energy requirements and sources of the Euratom community are summarized, together with the reactor construction program. The future of nuclear power is considered, and the status and problems of nuclear power development in Japan are outlined. The activities of the European Nuclear Energy Agency are also summarized. (D.C.W.)

1921 NUCLEAR POWER PLANT. Jakob Kaegi (to Sulzer Freres). U. S. Patent 3,152,962. Oct. 13, 1964. Priority date Sept. 21, 1960, Switzerland.

A steam cooling and power producing system was designed for a nuclear reactor in which the power required for circulating the steam through the reactor is considerably reduced. The steam forming the cooling medium of the reactor, and superheated therein, is divided into two streams. One stream is expanded in a steam engine and condensed. The condensate is pumped at increased pressure through a surface or indirect heat exchanger, and at least partly evaporated there by heat received from the steam forming the second stream and conducted as heating agent through the heat exchanger. The steam forming the second stream is circulated by a blower and the first stream emerging from the heat exchanger is mixed with the second stream downstream of the blower. The steam that is slightly superheated by adiabatic compression in the circulating blower is cooled to saturation temperature by the admixture of wet steam produced in the heat exchanger and the cooling effect of the steam forced by the blower into the reactor is increased. (M.C.G.)

Propulsion and Space

Refer also to abstract 1914.

1922 (AI-Memo-7585(Rev.I)) NUCLEAR SPACE POWER SYSTEMS. H. M. Dieckamp (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). [Nov. 1, 1963]. 144p. Dep.(mn).

A review is presented of technological developments in the SNAP programs, and future tests and the out-look for actual flights are discussed. (R.E.U.)

1923 (ANL-6857) VAPOR CYCLE COOLANT REQUIREMENT FOR NUCLEAR SPACE POWER PLANTS. Marion J. Janicke (Argonne National Lab., Ill.). Mar. 1964. Contract W-31-109-eng-38. 55p. Dep.; $3.00(cy), 1(mn) OTS.

Interplanetary space travel will require electric power in excess of 1 to 10 Mw. Present designs show that for these power demands, a coolant, rather than a radiation or conduction, heat-transmission scheme will be required for the economic use of power-plant weight. Of the various electrical conversion systems, the turbo-electric system appears to be the most promising method for supply of this energy. The choice of the coolant is the most important decision in the planning of any space power plant. Liquid metals are especially suited for reactors with high thermal fluxes and high operating temperatures, because of their high thermal conductivities, low vapor pressures, and relatively high volumetric heat vapacities. They are stable at high temperatures and in intense radiation fields. The main disadvantage of liquid metals is that they may be corrosive at high temperatures. However, the temperature at which this condition occurs is that at which most other liquids are no longer usable as coolants. Mercury, rubidium, potassium, and sodium are coolants that vaporize at a temperature within the present state-of-the-art metallurgical limits. (auth)

1924 (EUR-1621.e(Vol.II)) TECHNICAL SAFETY EVALUATION OF THE N.S. "SAVANNAH." (THIRD SUPPLEMENT). (European Atomic Energy Community; Bureau Veritas, S. A., Paris; and Germanischer Lloyd, Hamburg). 1964. 48p. Dep.(mn).

The new features of the ship's installations and of her operating specifications related to the port and coastal waters operations are reviewed. The following points are covered: changes in the reactor compartment ventilation system including its filtering equipment and its activity monitoring system; solid and liquid waste treatment and liquid effluents release; emergency propulsion; containment vessel leak-rate; further considerations on the maximum hypothetical accident; and operating criteria for the ship in port and coastal waters. (auth)

1925 (FZK-182) MEASURED AND CALCULATED NUCLEAR RADIATION DISTRIBUTIONS IN LIQUID HYDROGEN. W. A. Hehs and G. E. Miller (General Dynamics/Fort Worth. Div. of General Dynamics Corp., Fort Worth, Tex.). Mar. 27, 1964. Contract NAS 3-3324. 42p. (NASA-CR-54003)

The radiation measurements and calculations obtained from a series of experiments designed to investigate the effects of nuclear heating in liquid hydrogen are reported. The experimental arrangement simulated the radiation source and liquid-hydrogen propellant-tank geometry of a typical nuclear rocket system. The operating capacity of the tank was approximately 125 gallons. Nuclear radiation measurements were made in and around the liquid-hydrogen tank with the tank both empty and full. The radiation detectors and techniques used in making these measurements are described, and the measurements are compared with calculated radiation intensities. The calculations include secondary-gamma-ray production in the liquid hydrogen as well as in other surrounding materials. Assumptions and methods utilized in performing these calculations are discussed. The measured and calculated radiation intensities are, in general, in quite good agreement. (auth)

1926 (FZK-186-1) NUCLEAR RADIATION HEATING IN LIQUID HYDROGEN. VOLUME I. DESCRIPTION AND EXPERIMENT AND DISCUSSION OF RESULTS. W. A. Hehs, B. O. McCauley, G. E. Miller, and D. M. Wheeler (General Dynamics/Fort Worth. Div. of General Dynamics Corp., Fort Worth, Tex.). June 30, 1964. Contract NAS-3-3324. 150p. (NASA-CR-54078)

A comprehensive collection of data is given for evaluating methods to calculate the nuclear-radiation energy-deposition rates and the resultant temperature distributions in liquid hydrogen in a pressurized tank. Nuclear measurements provide data to determine heating gradients in the liquid hydrogen and to determine the contributions of neutron interactions and gamma interactions to the total heating rates. Boil-off and self-pressurization measurements determined the total heat input into the cryogenic system. Temperature distributions in the liquid hydrogen were monitored under variable flow conditions: pressurization, flow rate, heating gradient, and heat input. No analysis of the resultant temperature distributions in the hydrogen was performed. Background information and accuracy of the data required to perform and evaluate an

analysis have been provided. The results of nuclear analyses made during the study with the C-17 shield penetration code and with the COHORT Monte Carlo procedures compare favorably with the measured nuclear-radiation distributions and energy-deposition rates. (auth)

1927 (SC-RR-64-502) RE-ENTRY FLIGHT DEMONSTRATION NUMBER ONE (RFD-1): DATA BOOK. C. E. Erickson (Sandia Corp., Albuquerque, N. Mex.). Sept. 1964. Contract AT(29-1)-789. 143p. Dep.; $4.00(cy), 1(mn) OTS.

Re-entry Flight Demonstration Number One (RFD-1) was launched on May 22, 1963, from the Scout launch complex at the NASA Wallops Station, Wallops Island, Virginia. Lift-off occurred at 04:38:14 Zulu time. Until 350 seconds, good quality telemetry signals were received at the Wallops Main Base Telemetry Station and the Mercury Station on Bermuda. No telemetry signals were received after 350 seconds, other than a very brief and noisy signal which was received at 383 seconds by one of the downrange aircraft. Total flight time was estimated to be of the order of 500 seconds. This, the second of seven volumes documenting RFD-1, contains the uninterpreted or "raw" data from the instrumentation employed. Included are radar plots, photographs obtained by various optical instruments, and the data transmitted by telemetry up to the time of r-f blackout. No post-blackout data are available, since no information was received from the telemetry system after the beginning of blackout. (auth)

1928 (UCRL-13121) TORY IIC SERVO ACTUATOR SYSTEMS. Final Progress Report, January 1–August 31, 1964. (Bendix Corp. Research Labs. Div., Southfield, Mich.). For Univ. of California Lawrence Radiation Lab., Livermore. Contract AT(29-2)-705. 29p. (BC-2676) Dep.(mn); $2.00(cy), 1(mn) OTS.

The fabrication, assembly, and testing of five vernier and nine shim electropneumatic acutator systems for the Tory IIC ground test reactor control rods are discussed. The shim actuators consist of the servomotor 56:1 ratio transmission, clutch, rack and pinion assembly, scram and snubbing systems, linear transducer, servo amplifier, and oscillator. Endurance testing of the torque motor spring and armature assembly is reported. (N.W.R.)

1929 SHIP PROPULSION. Nucleonics, 22: No. 10, 81-3(Oct. 1964).

A summary is given of the Geneva Conference papers on maritime reactors including the Soviet Union's Lenin, Germany's Otto Hahn, the Anglo-Belgian Vulcain Project, NERO, the Dutch design-and-development project, and Norway's Kjeller organization. (C.E.S.)

1930 NUCLEAR ENERGY IN SPACE. Erik S. Pedersen. Prentice-Hall International Series in Space Technology. Englewood Cliffs, N. J., Prentice-Hall, Inc., 1964. 525p. $17.95.

The development of nuclear power for space propulsion is discussed. The topics include nuclear rocket propulsion theory, heat transfer and fluid flow analysis, nuclear reactor theory, materials in space, nuclear rocket engine design, advanced space propulsion systems, direct space power conversion, nuclear weapons in space, and space environment and radiation hazards. (C.E.S.)

1931 MARITIME APPLICATIONS OF NUCLEAR ENERGY. p.17-35 of "Proceedings of the Tenth Anniversary Conference of the Atomic Industrial Forum." New York, Atomic Industrial Forum, 1964.

The interest and difficulties in oceanography are indicated, together with power requirements. The program for development of nuclear power for merchant vessels is then discussed, emphasizing experience with the Savannah. The economics of nuclear merchant vessels are also outlined; and the Consolidated Nuclear Steam Generator, based on Savannah is briefly described. (D.C.W.)

1932 THE NUCLEAR SPACE PROGRAM–NATIONAL GOALS AND GOVERNMENT ORGANIZATION. A PANEL DISCUSSION. p.97-109 of "Proceedings of the Tenth Anniversary Conference of the Atomic Industrial Forum." New York, Atomic Industrial Forum, 1964.

The objectives and management of the nuclear space program are discussed. (D.C.W.)

Research and Test Reactors

1933 (HW-82888) TUBING FAILURE IN THE PRTR RUPTURE MONITOR HEAT EXCHANGER. R. V. Dulin (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). July 1, 1964. Contract AT(45-1)-1350. 12p. Dep.(mn); $1.00(cy), 1(mn) OTS.

A leak which was detected in the PRTR rupture monitor heat exchanger (HX-5) was successfully pinpointed to a leaking section of primary tubing with a hole worn through the tube wall where the tubing passed through a cooling water baffle. The wear was attributed to flutter of the tubing in the secondary cooling water flow streams. Further testing, measurement, and examination of the heat exchanger revealed that significant damage was limited to the failed tube and one other. These were taken out of service and operating conditions adjusted to minimize further wear. Considerable difficulty was experienced in stopping leaks where fittings were installed for pressure testing. A stress crack which developed exterior to the heat exchanger may have been due to the use of a chloride-containing tape used in "bagging" fitting leaks. Examination and analysis indicates that with the planned inspection and monitoring, the rupture monitor heat exchanger can be expected to continue operation indefinitely. (auth)

1934 (JAERI-1060) AUTOMATIC START-UP OF A RESEARCH REACTOR. Kenji Sumita, Takeo Fujisawa, and Koichi Watanabe (Japan Atomic Energy Research Inst., Japan). Jan. 1964. 63p. (In Japanese). Dep.(mn).

The control quality (various characteristics and performances of a control system in transient and steady states) of an automatic startup system, which must be understood before design in a practical system to automate the startup of JRR-1, is described. Although limited to systems based on period and power control, the results obtained can be extended to the system design of automatic startup of other research reactors. First, period and power transfer functions are introduced to examine the control quality of a simplified model of automatic startup. Next, the transfer function of an adder circuit in the feedback network of the model is derived, including a time-varying gain factor in it. Using these transfer functions, gain-phase curves of the loop of the model are calculated. The transient performances, which are expected from the curves, are confirmed on an analog computer. In addition, two period-setting methods are compared in their effects on the control quality of the period control system. As the next step toward putting into practice the full range automatic startup of JRR-1, the design problem of a log counting-rate and period meter (LCRPM) used for period control in the counter range is described. The design basis is to find the optimum point of compromise between the two requirements such as smaller period signal fluctuations and faster response of the LCRPM, under condition that the pulse sequence coming from a fission counter is Poisson-distributed. Then, the LCRPM of optimum design is applied to the automatic startup experiments at JRR-1, ranging from 3 mw of power (or 20 cps) up to about 2 kw. The experiments demonstrate the applicability of the design method and the feasibility of full range automatic startup. (auth)

1935 (PAEC(D)RE-647) CONTROL BLADES CALIBRATION BY DISTRIBUTED POISON METHOD. N. P. Penas and Z. M. Bartolome (Philippines. Atomic Energy Commission. Atomic Research Center, Manila). Apr. 1964. 22p. Dep.(mn).

Reactivity worths of control blades for PRR-I were experimentally determined by the poison insertion method. Boron-impregnated polyethylene strips were used. Tabulated results are given. (R.E.U.)

1936 (PAEC(D)RE-648) FLUX MAPPING THE 6 × 5 PRR-I CORE. Z. M. Bartolome, Q. O. Navarro, R. M.

Reyes, and C. A. Tejada (Philippines. Atomic Energy Commission. Atomic Research Center, Manila). 1964. 37p. Dep.(mn).

Thermal-neutron flux maps for the complete 6 × 5 core in PRR-I are given from foil activation data. (R.E.U.)

1937 (PAEC(D)RE-649) REACTIVITY EFFECT OF FUEL ADDITION IN THE PRR-I. Z. M. Bartolome and C. A. Tejada (Philippines. Atomic Energy Commission. Atomic Research Center, Manila). 1964. 4p. Dep.(mn).

Results are given of reactivity gains in PRR-I due to fuel addition or removal at various core positions. (R.E.U.)

1938 THE RESEARCH REACTORS OF THE NUCLEAR RESEARCH INSTALLATION AT JULICH. J. Fassbender (Kernforschungsanlage, Julich, Ger.). Atompraxis, 10: 393-7(Sept.-Oct. 1964). (In German)

The Nuclear Research Installation at Julich has available two research reactors. The Reactor FRJ-1 (MERLIN), a tank reactor with 5 Mw thermal output, was constructed from 1958 to 1961, became critical on February 23, 1962, and reached its first full output on July 25, 1963. The Reactor FRJ-2 (DIDO), a heavy water moderated tank reactor with 10 Mw thermal output and with highly enriched fuel elements, completed in the summer of 1962, went critical November 14, 1962, and reached full power September 4, 1963. After completion of the start-up research, the operation of the reactors at full power was initiated. (tr-auth)

1939 IRRADIATION ARRANGEMENTS AT THE REACTORS AT JULICH. M. Pollermann (Kernforschungsanlage, Julich, Ger.). Atompraxis, 10: 398-401(Sept.-Oct. 1964). (In German)

The Julich reactors have irradiation facilities for thermal neutron fluxes up to 1.4×10^{14} cm^{-2} sec^{-1} and fast fluxes E > 1 Mev up to 8×10^{13} cm^{-2} sec^{-1}. They include two pneumatic tube installations, a fast pneumatic tube, an input device for irradiations at the core of the FRJ-1, and rigs for capsule irradiation and materials testing at the FRJ-2. (tr-auth)

1940 BEAM-TUBE EXPERIMENTS AT THE RESEARCH REACTORS FRJ-1 (MERLIN) AND FRJ-2 (DIDO). H. H. Stiller and T. Springer (Kernforschungsanlage, Julich, Ger.). Atompraxis, 10: 401-6(Sept.-Oct. 1964). (In German)

The experiments in progress at the FRJ-1 and FRJ-2 reactors were described. Two motion diffractometers, a transit time and a triaxial spectrometer for the determination of lattice oscillation spectra and dispersion curves, and an installation for investigation of small-angle scattering of slow neutrons were available for solid-state physical problems. A mass spectrometer was used for the selection of energetic fission fragments. Two special devices for the detection of very low-background beams of thermal or subthermal neutrons were used for the study of neutron-capture gamma radiation. (tr-auth)

1941 ENGINEERING RESEARCH AT THE INSTITUTE FOR REACTOR CONSTRUCTION. H. Grosse (Kernforschungsanlage, Julich, Ger.). Atompraxis, 10: 407-12 (Sept.-Oct. 1964). (In German)

The Institute for Reactor Construction is concerned chiefly with the engineering and scientific problems of reactor construction, as they relate to the development of economic power reactors. A series of special test loops for the study of heat exchange and flow technology were constructed, and a program for the testing of fuel elements in various coolants was developed for conditions similar to power reactor conditions. (tr-auth)

1942 PROJECTED RADIATION CHEMISTRY INVESTIGATIONS AT THE FRJ-1 NUCLEAR REACTOR (MERLIN). G. O. Schenck (Max-Planck-Institut fur Kohlenforschung, Mulheim, Ger.). Atompraxis, 10: 424-6(Sept.-Oct. 1964). (In German)

Two special radiation loops were constructed for the irradiation of gaseous and liquid systems in the radiation field of the FRJ-1 Reactor. Setting up the objective and the present state of the research planning were outlined, and studies on which the planning depends are described. (tr-auth)

1943 THERMAL UTILIZATION FACTOR IN THE "NORA" REACTOR CELL. Roman J. Bednarz and Janusz R. Mika (Inst. of Nuclear Research, Warsaw). Nukleonika, 9: 765-9(1964).

The one-velocity method based upon the Amouyal-Benoist theory of calculating the thermal utilization factor in the NORA reactor is presented. The results are found to be in a good agreement with experiment. (auth)

WASTE DISPOSAL AND PROCESSING

Refer also to abstract 760.

1944 (HW-81746(p.4.32-6)) INVESTIGATION OF THE DISPOSITION AND MIGRATION OF GROSS GAMMA EMITTERS BENEATH LIQUID WASTE DISPOSAL SITES. J. R. Raymond (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Wells immediately adjacent to liquid waste disposal sites were logged with a gamma scintillation probe to determine the penetration depth of radionuclides. Information is presented to show contamination magnitude and migration changes at several "typical" sites. Well scintillation logs are shown to illustrate changes in waste penetration at three waste disposal facilities that have different operational histories. (auth)

1945 (HW-81746(p.4.39-42)) MEASUREMENT OF SOIL PARAMETERS FOR PARTIALLY SATURATED FLOW. L. G. King (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

A program is in progress to measure simultaneously the relationships between the three soil parameters: permeability, capillary pressure, and moisture content. Moisture content measurements utilize the characteristics of soils having different degrees of wetness to attenuate the low-energy gamma rays from an ^{241}Am source. Capillary pressure and permeability are measured simultaneously using conventional techniques. These data, collected for typical project soils, were used as inputs to the "steady-state" computer program, which solves for the equilibrium waste-flow patterns beneath ground disposal facilities. (auth)

1946 (ORNL-P-605) MOVEMENT OF RADIONUCLIDES IN THE CLINCH RIVER. F. L. Parker, B. J. Frederick, and P. H. Carrigan (Oak Ridge National Lab., Tenn.). Oct. 6, 1964. Contract W-7405-eng-26. 14p. (CONF-772-1). Dep.(mn); $1.00(cy), 1(mn) OTS.

From Proceedings of the Third Sanitary Engineering Conference, Nashville, May 1964.

The effects of temperature on the movement of radionuclides in the Clinch River, a highly regulated river with stratified flow, was studied using Rhodamine B dye as a tracer. The dispersion of the dye was followed by fluorometric measurements at various sampling stations. The effects of water released from Melton Hill Dam on water flow and mixing of radioactive waste effluents from White Oak Creek, that discharges waste from Oak Ridge National Laboratory, were determined for various temperature profiles. (C.H.)

1947 A REVIEW OF THE ENVIRONMENTAL HAZARD OF RADIOACTIVE WASTES. Joe O. Ledbetter (Univ. of Texas, Austin). 15p. (CONF-672-1)

From American Society of Civil Engineers Environmental Engineering Conference, Salt Lake City, May 1964.

Types of radioactive wastes and hazards, both environmental and human, from such wastes are defined. Sources of radioactive waste hazards are identified, and methods for radioactive waste disposal are evaluated. (H.M.G.)

GENERAL AND MISCELLANEOUS

1948 (ACF-2) S-126—AXISYMMETRIC THIN SHELLS OF REVOLUTION. L. A. Ney (ACF Industries, Inc. Albuquerque Div., N. Mex.). Aug. 3, 1964. Contract AT(29-1)-1352. 80p. Dep.(mn); $3.00(cy), 2(mn) OTS.

S-126 is a Fortran II language program for solving a large class of stress and deflection problems of axisymmetric thin shells of revolution. The results for a sample problem (dome loaded by cryogenic helium) are given, and the program is listed in detail. (D.L.C.)

1949 (ANL-6919) ARGONNE NATIONAL LABORATORY PUBLICATIONS, JULY 1, 1963–JUNE 30, 1964. (Argonne National Lab., Ill.). Aug. 1964. Contract W-31-109-eng-38. 294p. Dep.; $6.00(cy), 5(mn) OTS.

A bibliography is presented of scientific and technical accounts originated at Argonne and published during the fiscal year 1964. Journal articles, reports, books, etc., are included, and the references are arranged according to the organizational Divisions of the Laboratory. Author and subject (keyword in title) indexes are included. (D.L.C.)

1950 (BNL-7710) INTERSTITIALS AND VACANCIES IN α-IRON. R. A. Johnson (Brookhaven National Lab., Upton, N. Y.). [1962]. Contract AT(30-2)-Gen-16. 37p. (CONF-543-12). Dep.(mn); $2.00(cy), 1(mn) OTS.

From American Physical Society 1964 March Meeting, Philadelphia, Mar. 1964.

The migration energies and atomic configurations for mono- and di-interstitials and mono- and di-vacancies in α-iron were calculated using a classical model. About 530 atoms surrounding the defect were treated as individual particles, each with three degrees of freedom, while the remainder of the crystal was treated as an elastic continuum with atoms imbedded in it. A two-body central force was devised which matched the elastic moduli, was sharply repulsive at close separation, and which went to zero midway between the second and third neighboring atoms. Configurations were found by choosing a starting configuration roughly approximating the situation under consideration and successively adjusting the value of each variable occurring in the energy equation so that the magnitude of the generalized force associated with it was zero until equilibrium was reached. The energy calculations include changes in bond energy in the discrete region, energy in the elastic field, and work done against cohesive forces, but neglect changes due to the redistribution of electrons. Calculated activation energies for motion of mono- and di-interstitials and mono- and di-vacancies were 0.33, 0.18, 0.68, and 0.66 ev respectively, and binding energies of di-interstitials and di-vacancies were 1.08 and 0.20 ev respectively. The stable interstitial was a "split" configuration in which two atoms were symmetrically split in a ⟨110⟩ direction about a vacant normal lattice site, and the stable di-interstitial consisted of two parallel split interstitials at nearest neighbor lattice sites with their axes perpendicular to the line joining their centers. In the vacancy configuration an atom was missing from a normal lattice site, and the divacancy consisted of two vacancies at second nearest neighbor lattice sites. (auth)

1951 (BNL-7906) CALCULATIONS OF THE ENERGY AND MIGRATION CHARACTERISTICS OF CARBON AND NITROGEN IN α-IRON AND VANADIUM. R. A. Johnson, G. J. Dienes (Brookhaven National Lab., Upton, N. Y.), and A. C. Damask (Brookhaven National Lab., Upton, N. Y. and Frankford Arsenal. Pitman-Dunn Lab., Philadelphia). [1964]. Contract AT(30-2)-Gen-16. 32p. (CONF-543-11). Dep.(mn); $2.00(cy), 1(mn) OTS.

From American Physical Society 1964 March Meeting, Philadelphia, Mar. 1964.

Various properties of carbon and nitrogen in iron and nitrogen in vanadium have been investigated with the aid of computer techniques. The metal-metal interaction was represented by a two-body central force which matches the elastic moduli, is sharply repulsive at close separation, and which goes to zero midway between the second and third neighboring atoms. 531 atoms surrounding the defect were treated as individual particles, while the remainder of the crystal was treated as an elastic continuum with atoms imbedded in it. The iron–carbon interaction was represented by a cubic equation with the parameters chosen to yield the experimental value for the carbon migration energy, the activation volume (effectively zero), and the binding energy of a carbon atom to a vacancy. With this model the approximate experimental value of the energy of a carbon atom in solution in iron relative to Fe_3C was obtained. The model also gives the correct relaxation strength for internal friction, but does not reproduce closely the formation volume. The migration path for carbon, on the basis of this calculation, is a straight line from octahedral to octahedral position with the tetrahedral position as the saddle point. The behavior of nitrogen in iron is almost identical. The same method of calculation for nitrogen in vanadium reproduced closely the sizable experimental activation volume for this system. Some calculations of di-carbon formation and motion are also reported. (auth)

1952 (BNL-8420) SYNTHESIS AND RESOLUTION OF DL-KYNURENINE (KETO-^{14}C). Lawrence V. Hankes (Brookhaven National Lab., Upton, N. Y.). [196?] Contract AT-30-2-GEN-16. 12p. (CONF-774-1) Dep.(mn); $1.00(cy), 1(mn) OTS.

From International Symposium on the Preparation and Biomedical Application of Labeled Molecules, Venice, Aug. 1964.

DL-kynurenine (keto-^{14}C) was synthesized by using 2-nitroiodobenzene as a starting material, and the product was resolved into the D and L-isomers on a cellulose powder column. (auth)

1953 (BNL-8435) POINT DEFECT CALCULATIONS IN α-IRON. R. A. Johnson (Brookhaven National Lab., Upton, N. Y.). Sept. 14, 1964. Contract AT-30-2-GEN-16. 30p. (CONF-691-5). Dep.(mn); $2.00(cy), 1(mn) OTS.

From Conference on Fusion of Body-Centered Cubic Materials, Gatlinburg, Tenn., Sept. 1964.

Various properties of point defects in iron, vanadium, and tungsten have been investigated with the aid of computer techniques. The metal-metal interaction was represented by a two-body central force between first and second nearest neighboring atoms which matches the elastic moduli. About 530 atoms surrounding the defect were treated as individual particles, while the remainder of the crystal was treated as an elastic continuum with atoms imbedded in it. For α-iron, the calculated activation energies for motion of mono- and di-interstitials and mono- and di-vacancies were 0.33, 0.18, 0.68, and 0.66 ev respectively, and binding energies of di-interstials and di-vacancies were 1.08 and 0.20 ev respectively. For tungsten, the corresponding energies for interstitial and vacancy motion were 1.07 and 2.00 ev respectively. The stable interstitial was a "split" configuration in which two atoms were symmetrically split in a ⟨110⟩ direction about a vacant normal lattice site. A carbon-iron interaction was represented by a cubic equation with the parameters chosen to yield the experimental value for the carbon migration energy, the activation volume for motion (effectively zero), and the binding energy of a carbon atom to a vacancy. With this model, the approximate experimental value of the energy of a carbon atom in solution in α-iron relative to Fe_3C was obtained. The model also gives the correct relaxation strength for internal friction, but does not reproduce closely the formation volume. The stable configuration was the octahedral site in which the carbon atom sits midway between two second nearest neighboring iron atoms. The same method of calculation for nitrogen in vanadium reproduced the sizable experimental activation volume for this system. Some calculations of di-carbon formation and motion are also reported. (auth)

1954 (HW-68600-43) PLUTONIUM ABSTRACTS. Volume 4, Number 9. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Oct. 1, 1964. Contract AT(45-1)-1350. 20p. Dep.; $1.00(cy), 1(mn) OTS.

A total of 32 references is presented on new developments in plutonium technology. The references are arranged into the following subject fields: Biology & Medicine, Chemistry, Health & Safety, Metallurgy & Ceramics, Physics, and Miscellaneous. (D.L.C.)

1955 (HW-83801) WATER TREATMENT — THEORY AND PRACTICES — AS USED AT HANFORD ATOMIC PRODUCTS OPERATION. R. W. Pitman (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Aug. 25, 1964. Contract AT(45-1)-1350. 11p. (CONF-762-1) Dep.(mn); $1.00(cy), 1(mn) OTS.

From American Institute of Chemical Engineers, Regional Meeting, Longview, Wash., Oct. 1964.

The basic principles of the removal of suspended materials and large molecules from water are reviewed. The use of alum and activated silica in water treatment is discussed. Turbidity analysis of the water is being done using light-scattering microphotometry, and results are reported of an investigation of possible improvements of water treatment. The factors important to improved water treatment are listed. Savings of converting to the improved Hanford Water Treatment Process are tabulated for the Pasco, Washington, plant. (D.L.C.)

1956 (IDO-16994) MATERIALS TESTING REACTOR-ENGINEERING TEST REACTOR TECHNICAL BRANCHES QUARTERLY REPORT, JANUARY 1–MARCH 31, 1964. (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). Aug. 1964. Contract AT(10-1)-205. 79p. Dep.; $3.00(cy), 1(mn) OTS.

Experimental and theoretical studies of the performance of prototype ATR fuel elements for simulated hydraulic reactor conditions were initiated. Results of tests made on a solid side plate element fabricated by a welding technique show that venting of the side plates is required to minimize the lateral pressure differential obtained under flow conditions. Expressions were derived and are reported for the stresses obtained in Plates 18 and 19. The design of a zircaloy–stainless steel joint to be used in an in-pile facility was proved satisfactory in thermal cycle and mechanical vibrations tests. Fission yields of ^{135}I and of $^{135}I + {}^{135}Xe$ in ^{233}U relative to that in ^{235}U were found to be about 0.83 ± 0.06 in both cases whether for a 60- or 180-hr period of irradiation. New values of thermal cross sections are reported for five major isotopes of Dy. ARMF measurement of the resonance integral of ^{103}Rh gave a value of 1110 ± 100 barns, which is in reasonable agreement with 1062 barns calculated from published parameters. A value of 81 barns was obtained experimentally for the infinite dilution resonance integral of ^{232}Th. The concept of interference was formulated as the effect on the resonance integral caused by the lack of complete flux recovery between resonances. This type of interference was both measured and calculated for mixtures of ^{232}Th and ^{238}U, giving a 3% change in the total resonance integral of samples with an absorber density of 6 g/cm^3. Lethargy dependence of real and adjoint fluxes in the ARMF-II Cd tube was calculated with the S-XI transport code. The results were used to interpret reactivity measurements on ThO_2, $^{238}UO_2$, and ^{197}Au resonance integral samples. Formulation of Phillips' Monte Carlo Program has proceeded to the point where all basic flow charts are completed with the exception of the input and output routines, and most of the Monte Carlo subroutines were programmed and debugged. The total neutron cross section for ^{233}Pa was measured for neutrons at 0.01 to 20 ev. The thermal cross section is 57 ± 5 barns. The variation of the total kinetic energy of fission fragments of ^{235}U was measured at 0.02 to 1 ev neutron energy by a new method. Samples of ^{204}Tl, ^{36}Cl, and ^{182}Ta are being prepared by neutron irradiation for fast chopper samples. Similarities between the room temperature gaseous methane, cold gaseous methane, liquid methane, and solid methane data indicate that free rotations persist in all three states. A study of the decay of ^{194}Os, produced by double neutron capture on ^{192}Os, was carried out, and certain features of the level structure of ^{194}Ir were studied. Further investigations into the level structure of ^{197}Au were made. The decay schemes of the activities ^{197}Hg, ^{197m}Hg, and ^{197}Pt were studied to provide this information. A unique, predictable source of noise, offering many advantages over conventional techniques, was developed. Instrument system progress on the Advanced Test Reactor Critical Facility is described. An improvement to the ETR compensated ion chamber power supply is described. An accident study was made on the ETR, employing digital computer techniques, which revealed the power-time history and total energy release for several situations. An analog computer simulation of several transient hydraulic flow situations envisaged for LOFT is discussed. An analog computer study was made of hydraulic fluid contamination of the In-Pile Fatigue Testing Actuator. Experimental measurements of β/ℓ for the ETRC and of several kinetic parameters for the SNAP 10A SNAPTRAN Reactor employing noise analysis techniques are described. The following new IBM-7040 programs were completed: NLLS, a general nonlinear least-squares fitting program; DUZIT, which analyzes ARMF data; a program to generate the calibration curves for the ARMF: TOPIC 4, 6, 8, 10, a series of cylindrical transport codes; MIST 4, 6, 8, 10, a series of slab transport codes; HETFLX, a heat flux code for reactor fuel elements; a program to process total cross section data; FES1, a fuel element design program; HEATING, which computes steady-state or transient temperature distributions in three-dimensions; BURNOUT, a program to compute the change in fuel concentration in MTR elements; a random number generator for use in Monte Carlo computations; and a subroutine for general Lagrangian interpolation. Nearly completed were MACABRE, a program to analyze ATR fuel elements, and a multi-level cross section convolution program. (auth)

1957 (NYO-1480-6) NUMERICAL STUDIES OF FRONTAL MOTION IN THE ATMOSPHERE. [PART] I. A. Kasahara, E. Isaacson, and J. J. Stoker (New York Univ., New York. Courant Inst. of Mathematical Sciences). Sept. 1964. Contracts AT(30-1)-1480 and NONR-285(55). 60p. Dep.(mn); $3.00(cy), 2(mn) OTS.

The motion of frontal disturbances in the atmosphere is studied by the numerical solution of differential equations based upon a two-layer model of an incompressible fluid on a rotating earth. The density of each layer is assumed to be constant. The upper and lower fluids correspond respectively to warm and cold air. Only the motion of the lower cold air layer is studied by assuming, in effect, that the dynamics of the perturbations in the upper warm air layer can be neglected. The numerical study of this simple mechanical model shows that even though thermodynamic processes have been ignored, the occlusion process, characteristic for warm and cold fronts, develops from an initially sinusoidal frontal pattern. Two cases of different initial conditions are examined. Case A: Only the east-west component of wind velocity is initially geostrophic. Case B: Both east-west and north-south components are initially geostrophic. In both cases, computations indicate that the cold front propagates faster than the warm front and that a relatively strong mass convergence zone appears behind the cold front only. This fact suggests the occurrence of severe storms associated with cold fronts, but not with warm fronts in the atmosphere. The numerical method developed to calculate the movement of the front is based on following the motion of the material "particles" at the front. This method has applications to the numerical solution of a certain class of hydrodynamic flow problems in which the entire boundary of the domain of integration is not given a priori, but must be determined (so-called free-boundary problems). (auth)

1958 (NYO-2471-3) INTERNAL FRICTION AND ELECTRON MICROSCOPY STUDIES ON MAGNESIUM (thesis). Report No. 240. Robert Tsang-Chu Tsui (Cor-

nell Univ., Ithaca, N. Y.). Sept. 1964. Contract AT(30-1)-2471. 119p. Dep.(mn); $4.00(cy), 3(mn) OTS.

Internal friction of polycrystals and single crystals of pure and doped magnesium was studied between 4.2 and 300°K at frequencies of about 4 and 40 kc. Two kinds of internal friction peaks were found in plastically deformed specimens. A broad peak which shows some structures and occurs between 70°K and 240°K in both polycrystals and single crystals after coldwork, is shown to be caused by dislocations in the basal slip system. Dislocations in the prismatic and pyramidal glide systems do not contribute to the internal friction. The peak at 20°K appears in polycrystals only after a relatively large amount of coldwork (>3%). This peak does not seem to be caused by dislocations in the basal, prismatic, or pyramidal systems. Effects of different impurities, in particular the effect of precipitates, were observed. Direct observations of dislocation structures were obtained by means of transmission electron microscopy. The dislocation density in the basal plane in well annealed single crystals is between 10^3 and 10^6 per cm^2 while the density after small amount of deformation (1%) is about 5×10^7 per cm^2. Hexagonal vacancy loops were observed in the basal plane after 1% compression. $\{10\bar{1}2\}$ twinning was also observed in samples deformed by compression along the basal plane. These observations correlate with the internal friction results. (auth)

1959 (ORNL-3682) ISOLATION, PURIFICATION, AND SOME PROPERTIES OF P^1,P^4-DIGUANOSINE 5′-TETRAPHOSPHATE ASYMMETRICAL-PYROPHOSPHOHYDROLASE FROM BRINE SHRIMP EGGS. A. H. Warner (Oak Ridge National Lab., Tenn.). Oct. 1964. Contract W-7405-eng-26. 34p. Dep.; $2.00(cy), 1(mn) OTS.

Thesis submitted to Southern Illinois Univ., Carbondale.

Encysted embryos of Artemia salina have been studied extensively by classical embryologists and geneticists but unfortunately very little biochemical information on their embryonic development has come forth. Unlike most organisms, these embryos can be maintained anabiotically for several years under the most adverse environmental conditions and then resume normal development upon immersion in sea water. The recent finding that large quantities of a unique pyrophosphate ester, P^1,P^4-diguanosine 5′-tetraphosphate (di-GDP), occur in encysted embryos of Artemia salina prompted the search for an enzyme system in the undeveloped egg capable of attacking this compound. The isolation and purification of a new pyrophosphohydrolase capable of hydrolyzing di-GDP is reported. This enzyme, P^1,P^4-diguanosine 5′-tetraphosphate asymmetrical-pyrophosphohydrolase (asym-di-GDPase), apparently has an absolute substrate specificity and produces equimolar quantities of guanosine monophosphate and guanosine triphosphate from diguanosine 5′-tetraphosphate. (auth)

1960 (ORNL-P-517) EFFECTS OF A PESTICIDE ON BIOTA AND BREAKDOWN OF FOREST LITTER. D. A. Crossley, Jr., and Martin Witkamp (Oak Ridge National Lab., Tenn.). [Sept. 25, 1964]. Contract W-7405-eng-26. 10p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The separate roles of fauna and microflora in the breakdown of leaf litter and mineralization of humus on the floor of an oak forest were evaluated. Plots of oak leaf litter (Quercus alba) that contained ^{134}Cs, introduced by trunk inoculation when the leaves were green, were treated with naphthalene, which greatly reduced the number of leaf-fragmenting arthropods but did not affect the microflora. Weekly measurements on litter bags provided data on loss of weight, loss of ^{134}Cs, and number of arthropods. Biweekly measurements were made of soil and litter respiration and of microbial densities. A comparison with data from control plots showed that litter without soil fauna lost little weight. The experimental results emphasized the importance of both soil microflora and soil fauna in the breakdown of forest litter and mineralization of ^{134}Cs in forest humus. (C.H.)

1961 (ORNL-P-586) ENVIRONMENTAL INFLUENCES ON MICROBIAL POPULATIONS AND ACTIVITY OF THE FOREST FLOOR. Martin Witkamp (Oak Ridge National Lab., Tenn.). [1964]. Contract W-7405-eng-26. 19p. (CONF-712-2). Dep.(mn); $1.00(cy), 1(mn) OTS.

From 8th International Congress of Soil Science, Bucharest, Romania, Aug.-Sept. 1964.

A study was made of microbial populations active in the breakdown of leaf litter and subsequent mineralization and humus formation. Emphasis is placed on quantitative relationships of microflora and microbial activity with each other, with environmental factors, and with rates of litter breakdown. Microbial activity of litter and soil was measured by rates of CO_2 evolution in closed boxes or in boxes without bottoms on the forest floor. Microbial populations were enumerated by standard dilution plate methods and direct counts of fungal mycelium on soil suspension slides. Data are presented from studies of European and American forests. (C.H.)

1962 (ORNL-P-594) COMPARISON OF THE THERMAL CONDUCTIVITY, ELECTRICAL RESISTIVITY, AND SEEBECK COEFFICIENT OF A HIGH-PURITY IRON AND ARMCO IRON TO 1000°C. J. P. Moore, W. Fulkerson, D. L. McElroy, and T. G. Kollie (Oak Ridge National Lab., Tenn.). Oct. 6, 1964. Contract W-7405-eng-26. 29p. (CONF-764-5). Dep.(mn); $2.00(cy), 1(mn) OTS.

From Thermal Conductivity Conference, San Francisco, Oct. 1964.

In this study comparative values of the thermal conductivity, Seebeck coefficient, and electrical resistivity for Armco iron and a high-purity iron are reported. It is found that impurities decrease the electronic portion of the thermal conductivity, k_e, but do not change the lattice portion, k_l. The temperature dependence of the thermal conductivity of high-purity iron is similar to that of Armco iron with a slope change at about 436°C and again at 780°C, just above the Curie point. There is a drop in thermal conductivity of 6% at the α-γ transformation for high-purity iron and a 4% drop for Armco iron. The electrical resistivity is increased by impurities, and this change increases with temperature to the Curie point above which it is a constant indicating a magnetic effect. The electrical resistivity decreases at the α-γ transformation about 0.94 μohm cm for high-purity iron and 0.6 μohm cm for Armco iron. Cold working appears to increase the electrical resistivity having a maximum effect at about the Curie temperature. The Seebeck coefficient measured with respect to platinum is decreased by impurities which cause a 13% difference between high-purity and Armco iron at 0°C. This difference decreases with temperature and virtually disappears above 550°C. The shape of the Seebeck coefficient vs temperature curve is the same for both irons showing a pronounced minimum near 440°C and a sudden decrease at the α-γ transformation of some 40%. (auth)

1963 (SC-DC-64-491) FINAL REPORT OF EXPERIMENTAL STUDY TO DETERMINE THE MEAN TIME FOR THE OUTPUT OF AN RC NETWORK TO REACH A THRESHOLD WHEN CHARGED BY A RANDOM PULSE TRAIN. Technical Report EE-93. J. E. Leeman and W. W. Koepsel (New Mexico. Univ., Albuquerque. Engineering Experiment Station). Dec. 1963. For Sandia Corp., Albuquerque, N. Mex. Contract AT(29-1)-789. 53p. Dep.(mn); $3.00(cy), 1(mn) OTS.

An experimental effort to determine the relation between several system parameters and the mean time to charge an RC network to a preset threshold voltage when charged by a train of constant area pulses, whose appearance is random and independently determined for each pulse, is described. The other parameters are: area of charging pulse, threshold setting, probability of pulse occurrence, and time constant of the RC network. The design of the equipment and the results of the tests are described. (auth)

1964 (SC-DR-64-645) SOLDERING OF NOBLE METAL ALLOYS. D. S. Sasmor, F. Greulich, H. Romero, and K. E. Mead (Sandia Lab., Albuquerque, N. Mex.). Aug. 1964. Contract [AT(29-1)-789]. 33p. Dep.(mn); $2.00(cy), 1(mn) OTS.

The interaction and solubility of the noble metal alloy wires (platinum–iridium (10%), Paliney 7, Ney Oro G) with 60/40 tin/lead solder and a bimetallic wire (Pyrofuze)

with 94.5/5.5 lead/silver solder have been studied, using metallographic techniques and electron probe analyses. The results show that degradation of the mechanical properties of these materials does take place when they are soldered and is due to the formation of low melting eutectics and/or intermetallic compounds which are soluble in the liquid solder. These reactions generally result in a reduction of the wire diameter, embrittlement of the wire, or both. The amount of reaction or the degree of degradation is dependent on the temperature of the molten solder, and the length of time the two materials are in contact when the solder is molten. Although degradation during the solder process needs to be considered during design and carefully evaluated, past experience has shown that these materials can be successfully soldered. Electron probe analyses of samples stored at +165°F for extended periods (up to 4100 hours) indicate that no further measurable degradation between the wire alloys and the solder occurs during elevated temperature storage. (auth)

1965 (SC-TM-64-670) INVESTIGATION OF THE FERROELECTRIC PROPERTIES OF LEAD ZIRCONATE–TITANATE WITH STRONTIUM AND BARIUM ADDITIONS. C. A. Hall and R. L. Cook (Sandia Lab., Albuquerque, N. Mex.). Aug. 1964. Contract [AT(29-1)-789]. 27p. Dep.(mn); $2.00(cy), 1(mn) OTS.

Results are presented of an investigation of effects when lead was partially replaced by strontium or barium in lead zirconate–titanate solid solutions in the region of the ferroelectric-antiferroelectric (FE-AFE) phase boundary. Composition-temperature phase diagrams are presented to show the dielectric and ferroelectric properties measured. Substitution of barium favored the FE phase with only a small AFE area near $PbZrO_3$. Barium also markedly lowered the $FE_I - FE_{II}$ transition temperature. The replacement of lead by strontium increased the amount of titanium necessary to bring the onset of ferroelectricity and also reversed the stability of the FE and AFE phases with respect to temperature. The ferroelectric properties, although altered to some extent by barium and strontium, were not greatly changed. (auth)

1966 (SC-TM-64-984) WIND-TUNNEL TESTS OF THE TERRIER-TOMAHAWK ROCKET SYSTEM TO DETERMINE FORCE AND MOMENT COEFFICIENTS AT MACH NUMBERS OF 0.5 TO 2.0. S. W. Pearson (Sandia Lab., Albuquerque, N. Mex.). Aug. 1964. Contract [AT(29-1)-789]. 41p. Dep.(mn); $2.00(cy), 2(mn) OTS.

A wind-tunnel test of the Terrier-Tomahawk rocket system was made in the Sandia Corporation trisonic wind tunnel. The models were tested through an angle-of-attack range of −6 to +8 degrees to determine force and moment coefficients. The Terrier-Tomahawk vehicle was statically stable at all Mach numbers tested, but the Terrier booster was unstable at the lower tunnel Mach numbers. Results are presented in tabular and graphical form. (auth)

1967 (SLC-DC-64-83) INTERPRETATION OF DYNAMIC DATA FOR SINUSOIDAL AND RANDOM VIBRATION TESTING. B. C. Ellis (Sandia Corp. Livermore Lab., Livermore, Calif.). [July 1964]. Contract [AT(29-1)-789]. 13p. (CONF-701-9). Dep.(mn); $1.00(cy), 1(mn) OTS.

From Instrument Society of America 19th Annual Instrument-Automation Conference and Exhibit, New York, Oct. 1964.

A description is given of the methods of using shock and vibration information required to specify and test for the dynamic environments a weapon system will experience. The gathering of data employs complete data acquisition and playback systems. Sandia interprets these data so that realistic design specifications can be made for the most efficient design of structural members and hardware. (auth)

1968 (TID-20441(Vol.I)) ENERGY DEPOT ELECTROLYSIS SYSTEMS STUDY. Final Report. C. W. Schade, R. A. Foust, Jr., B. N. Thomson, M. J. Malik, W. L. Carr, and R. D. McLain (General Motors Corp. Allison Div., Indianapolis). June 1, 1964. Contract AT(30-1)-3101. 225p. (EDR-3714(Vol.I)). Dep.(mn); $6.00(cy), 4(mn) OTS.

The conceptual design of an efficient, lightweight, rugged, and compact mobile electrolysis unit for the production of hydrogen from water was evolved. The conceptual chemical plant will produce 7.15 T/day of annydrous ammonia with a power source of 3000-kw supplied at 4160 v, 3-phase, and 60 cps. The chemical plant is composed of three transportable skids, each weighing 30,000 lb or less. Catalytic electrodes were developed which are highly efficient in terms of power required to dissociate water into hydrogen and oxygen. Both acid and base systems were investigated. Material compatibility studies were conducted. Approximately 150 test electrodes were fabricated to survey more than 20 electrode compositions. Two single dynamic test cells were operated to collect parametric data and finally, a ten-cell module was designed and tested. Detailed studies were made of power conditioning equipment, liquid gas separators, and overall system optimization. Engineering drawings of a conceptual electrolysis unit and detail drawings of a prototype electrolysis module were a part of this study. Experiments to determine the effect of impurities from corrosion products or impure feed water are reported. (auth)

1969 (TID-21221) RESEARCH CARRIED OUT UNDER THE EURATOM/UNITED STATES AGREEMENT. (European Atomic Energy Community). 1964. 169p. (EUR-1840.e). Dep.(mn); $5.00(cy), 3(mn) OTS.

Four monographs are presented which review the results of the Joint Research and Development Program in selected areas: thermohydrodynamics of two-phase flow, corrosion and oxidation, embrittlement of steels for reactor vessels, and uranium oxide development. Separate abstracts were prepared for all four monographs. (D.L.C.)

For abstracts of individual papers see: 588, 907, 931, and 966.

1970 (TID-21230) SUSPENSION OF SOLIDS BY MIXING IMPELLERS. Final Report. J. H. Rushton (Purdue Univ., Lafayette, Ind. School of Chemical Engineering). Oct. 19, 1964. Contract AT(11-1)-804. 4p. Dep.(mn); $1.00(cy), 1(mn) OTS.

A summary is presented of the results obtained in the investigation of variables in the mixing of solids in liquids by impellers. Correlations of the results were developed which give the critical power and speed needed to suspend all of the solids. It was found that the particle shape has very little effect on the critical power, that tank size has an important effect on the critical speed, and that for large units the Fan type Turbine is preferred over the Flat Blade Turbine impellers for large units. (D.L.C.)

1971 (UCRL-7438) CHEMICAL REACTIVITY TESTING OF EXPLOSIVES. J. W. Frazer and K. Ernst (California. Univ., Livermore. Lawrence Radiation Lab.). July 18, 1963. Contract W-7405-eng-48. 20p. Dep.; $1.00(cy), 1(mn) OTS.

A chromatographic testing method is described for the quantitative determination of the volatile decomposition or reaction products, solvents, and other compounds. In this method, a three-stage gas chromatograph is used to resolve the various products and compounds, and its operation is described. Results are presented for PBX-9404 and numerous other explosives and explosive mixtures. The effects of temperature are discussed briefly. (D.L.C.)

1972 (UCRL-7973) PREPARATION AND STUDY OF A SERIES OF BORANE AND TRIBOROHYDRIDE DERIVATIVES OF METHYLATED POLYAMINES. Franklin E. Walker (California. Univ., Livermore. Lawrence Radiation Lab.). July 21, 1964. Contract W-7405-eng-48. 26p. Dep.; $2.00(cy), 1(mn) OTS.

A series of borane and triborohydride derivatives of methylated polyamines have been prepared, and the variance in certain of their chemical and physical properties has been studied. The basic series consisted of polyamine chains of two, three, and four nitrogens separated by two carbon atoms and a chain of three nitrogens separated by three carbon atoms. The qualitative hydrolytic, thermal,

and atmospheric stabilities were determined and the densities and other physical properties were compared. (auth)

1973 (UCRL-11211) THE ELECTRON SPIN RESONANCE SPECTRUM OF THE RADICAL-ANION OF 1,3-BUTADIENE IN LIQUID AMMONIA. Donald H. Levy and Rollie J. Myers (California. Univ., Berkeley. Lawrence Radiation Lab. and California. Univ., Berkeley. Dept. of Chemistry). Apr. 1964. Contract W-7405-eng-48. 18p. (CONF-553-12). Dep.(mn); $1.00(cy), 1(mn) OTS.

From American Ceramic Society 66th Annual Meeting including Symposium on Nuclear and Space Applications, Chicago, Apr. 1964.

The electron spin resonance spectrum of the radical-anion of 1,3-butadiene has been observed by means of continuous electrolysis in liquid ammonia. The proton coupling constants were observed to be A(CH) = 2.791 ± 0.007 Oe and $A(CH_2)$ = 7.617 ± 0.005 Oe. These values give a Q(av.) = 20.82 ± 0.02 Oe. The source of this low Q value is discussed together with theoretical spin densities. Simple Hückel theory predicts a spin density ratio of 2.615 which can be compared with the observed coupling constant ratio of 2.729 ± 0.007. The predictions of Parr and Mulliken's SCF theory are much less satisfactory and give a low spin density ratio. Electrolysis in liquid ammonia appears to be an excellent method for the generation of radical-anions. (auth)

1974 (UCRL-11374) THE ELECTRICAL, MAGNETIC, AND OPTICAL PROPERTIES OF SOME COMPLEX ORGANIC SYSTEMS (thesis). David Frederick Ilten (California. Univ., Berkeley. Lawrence Radiation Lab.). May 1964. Contract W-7405-eng-48. 98p. Dep.(mn); $3.00(cy), 2(mn) OTS.

A variety of organic donor-acceptor complexes, both solutions and solids, have been investigated as possible model systems for photosynthetic processes. The aim of the study was to obtain information concerning charge transport and charge separation phenomena in organic materials. The optical dichroism of crystals of coronene-p-chloranil charge-transfer complex was studied. The charge-transfer band was found to be polarized along the needle axis of the crystal—that is, along the line of centers joining the molecules. Photoinduced electron paramagnetic resonance (EPR) signals were observed in the coronene-chloranil complex. Attempts were made to correlate heat-induced EPR signals with heat-induced changes in the electric conductivity of perylene-o-chloranil crystalline complex. There appeared to be no simple relationship between the two phenomena. A search for photoinduced EPR signals in liquid complexes was carried out, and a number of systems were found with photosignal rise times of less than one second. The solution most extensively studied was p-chloranil dissolved in dioxane. In this case the rise time for the EPR photosignal was approximately 30 msec. Side reactions, however, complicated the interpretation of the data. The complex formed between tetracyanoethylene (TCNE) and tetrahydrofuran (THF) was not so reactive when irradiated. Also, the free radical produced could be readily identified from its hyperfine structure to be TCNE negative ion radical. The kinetics for the formation of TCNE negative ion radical by light were studied, and a reaction mechanism was proposed. The data for the photoinduced EPR signals were correlated with data obtained for photoconductivity in the same TCNE-THF system. A kinetic scheme was developed which appeared to be applicable to both the photoconductivity and the photoinduced EPR. The data gave evidence for a reversible photoinduced charge separation in a liquid organic system. (auth)

1975 (UCRL-11542) OPTICAL TECHNIQUES FOR THE STUDY OF DIFFUSIONAL MASS TRANSFER. R. H. Muller (California. Univ., Berkeley. Lawrence Radiation Lab.). July 21, 1964. Contract W-7405-eng-48. 23p. Dep.(mn); $1.00(cy), 1(mn) OTS.

A brief review is given of potential optical techniques for the determination of diffusion constants in heterogeneous mass transfer in solution. Schlieren and interferometric methods are included. An extensive bibliography is included. (D.L.C.)

1976 (UCRL-11581) A CALORIMETRIC STUDY OF LIQUID GOLD–TIN ALLOYS NEAR THE COMPOSITION AuSn (thesis). Jean-Louis Daniel Guy Masse (California. Univ., Berkeley. Lawrence Radiation Lab.). Aug. 1964. Contract W-7405-eng-48. 23p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The relative partial molar enthalpies of gold and tin in liquid gold–tin alloys have been measured by liquid metal solution calorimetry at a temperature just above the congruent melting point of AuSn from x_{Sn} = 0.475 to x_{Sn} = 0.510. The results are represented, within a maximum scatter of ±20 cal/g atom, by two curves which do not reveal any anomalous behavior at the equiatomic composition. The data are discussed in relation to eixsting x-ray diffraction studies of the liquid and are compared with previous thermodynamic measurements. (auth)

1977 (UR-652) SOLID HOMOGENEOUS AEROSOL PRODUCTION BY ELECTRICAL ATOMIZATION. Edward P. Yurkstas and Charles J. Meizenzehl (Rochester, N. Y. Univ. Atomic Energy Project). Oct. 14, 1964. Contract W-7401-eng-49. 39p. Dep.; $2.00(cy), 1(mn) OTS.

A description is given of research into the generation of solid homogeneous aerosols from a source producing uniform, charged droplets from liquid solutions by electrical atomization. The process involves the ejection of the material from a capillary and its disruption in air or other gaseous medium by the application of an electrical field to the material. The development of the method together with the mechanism for uniform droplet and then particle formation, the relations involving the physiochemical properties of the source and the material to be ejected, along with considerations for stable and continuous production of the aerosol are discussed. (auth)

1978 (VUF-1010) STRUCTURAL SURVEY OF PRIVATE MINING PROPERTIES. (Bureau of Mines, Reno, Nev.). Dec. 1963. Project SHOAL. 186p. Dep.; $4.00 (OTS).

The pre-shot and postshot mine surveys indicated that no damage attributable to the Shoal event occurred to any of the sixteen private mining properties. The only evidence of physical change was found in the Northern Dipper and Nevada Scheelite Mines where minor rock falls occurred between the pre- and postshot mine surveys. All the rock falls were in mine areas not in present use, and it is not certain that these rock falls were caused by the Shoal event. Measurements by the U. S. Public Health Service indicated no measurable differences between pre-shot and postshot radiation levels. It is concluded from the pre- and postshot mine inspection surveys that the Shoal event caused neither physical damage nor radiation contamination to the mine properties inspected. (D.L.C.)

1979 (VUF-1015) PRESHOT AND POSTSHOT STRUCTURE SURVEY. Final Report. (Holmes and Narver, Inc., Las Vegas, Nev.). Dec. 1963. Contract AT (29-2)-20. Project SHOAL. 212p. Dep.; $6.00 (OTS).

The structures surveyed included various residential structures, mine surface structures, and a windmill at distances of from three to 52 miles from ground zero. No damage was observed and it can be concluded that for comparable future projects no damage would result to similar structures at comparable yields and ranges. It is further concluded that the survey procedures outlined in the Operational Safety Plan, Project Shoal, were adequate to accomplish the survey objectives. (auth)

1980 (VUF-1017) FEDERAL AVIATION AGENCY AIRSPACE ADVISORY. Final Report. H. M. Vick and A. D. Carter (Federal Aviation Agency. Los Angeles Air Route Traffic Control Center, Palmdale, Calif.). [nd]. Project SHOAL. 13p. Dep.; $1.00 (OTS).

The FAA has concluded that the Project Shoal Air Space Advisory Plan provided all proper precautions necessary to ensure against radioactive contamination of airmen or aircraft. (auth)

1981 (Y-IA-7) MAINTENANCE WORK MEASUREMENT. T. C. Trotter (Union Carbide Corp. Nuclear Div. Y-12 Plant, Oak Ridge, Tenn.). Oct. 12, 1964. Contract

W-7405-eng-26. 24p. (CONF-767-1). Dep.(mn); $1.00 (cy), 1(mn) OTS.

From AEC Plant Facilities Management Meeting, Miamisburg, Ohio, Oct. 1964.

The Maintenance Division of The Oak Ridge Y-12 Plant is engaged in a broad work control program, designed to gain more effective use of manpower and materials. A discussion is presented of work measurement as a managerial tool in such a program. (auth)

1982 (JPRS-25966) RADIOCHEMICAL AND ECOLOGICAL STUDIES OF THE SEA. Translated from Okeanologiya, 4: 369-79; 418-36; 477-8; 516-34(1964). 93p. (TT-64-41237) $3.00(OTS).

Separate abstracts were prepared for three articles included in this translation. Other articles discuss the economic significance of the world oceans, the accumulation of Carangidae in the Gulf of Aden, photosynthesis of marine phytoplankton at various depths, and the relation of the size of water areas to fauna in brackish waters. (C.H.)

For abstracts of individual papers see: 22, 633, and 634.

1983 REPORT ON NUCLEAR ENERGY IN ITALY. Giuseppe Medici. Comit. Nazl. Energia Nucl., Notiziario, 10: 27-45(Aug.-Sept. 1964). (In Italian)

The full text of the report submitted to the Parliament by the Minister of Industry and Chairman of the C.N.E.N. is presented. A brief history is given of the activities and achievements of the C.N.E.N. during the first five-year program. The task of the organization and its structure are reported. The next five-year program of the C.N.E.N. is outlined in some detail. (J.S.R.)

1984 LEXIQUE NUCLEAIRE, ANGLAIS-FRANCAIS, FRANCAIS-ANGLAIS. (Nuclear Glossary—English-French, French-English). Paris, Presses Universitaires de France, 1964. 125p.

A French-to-English and English-to-French glossary of terms used in nuclear science and technology is presented. (T.F.H.)

1985 DICTIONNAIRE DES SCIENCES ET TECHNIQUES NUCLÉAIRES. (Dictionary of Nuclear Science and Techniques). Paris, Presses Universitaires de France, 1964. 224p.

The dictionary gives definitions in French of over 2000 French terms encountered in nuclear science and technology. (T.F.H.)

1986 ENERGIE ATOMIQUE ET PROTECTION CONTRE LES RADIATIONS EN SUISSE. (Atomic Energy and Protection Against Radiation in Switzerland). Bern, Association Suisse pour l'Energie Atomique, 1963. 401p.

A Swiss atomic manual, including a review of the development of nuclear energy in Switzerland, a guide to the federal regulations, the legal texts, a listing of the Swiss and international authorities and organization, tabulation of the Swiss research centers, and data on the organization of atomic economy, is presented. It is a loose-leaf manual to be supplemented in the future as the need arises. (J.S.R.)

1987 A COLLECTION OF PAPERS ON NUCLEAR SCIENCE AND ENGINEERING. Inam-ur-Rahman. Lahore, Atomic Energy Centre, 1963. 497p.

Nuclear propulsion of ships and aircraft, analysis of nuclear reactor accidents, pressurized water reactors, interaction of neutrons with different elements, disposal of radioactive wastes, fusion as a source of energy, fast reactors, and selection of suitable site for power reactor installation in Pakistan are discussed in the 8 papers presented. (C.E.S.)

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This index contains entries for this period for all report literature and, in addition, for certain published literature items for which it is felt that a corporate approach is especially desirable, e.g., symposia, conference proceedings, and meetings.

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ä	becomes	ae
ö		oe
ø		oe
ü		ue (except in transliterated Chinese names)

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SUBJECT INDEX

Main entries in this index are generally specific materials, things, and processes. These are followed by modifiers that describe the properties of, and processes applied to, the main entries.

The number preceding the colon is the *NSA* volume number, and the number following is the abstract number. The designation (R) following the abstract number indicates that the abstract is of a progress report; (P) indicates a patent; and (T) indicates a translation. Abstracts for reports other than progress reports carry no letter designation. References to report numbers, where appropriate, are included after the abstract number of the citation. Published literature (journal article or book) is indentifiable by the absence of a report number.

The user should bear in mind that the ideas presented in the original literature, rather than key words, have been indexed. The indexers have tried to select what seemed the most probable and logical place to look for typical information. Since it is not possible to anticipate where a user would look for information, numerous cross references are included to assist him in his search.

Experience in using an index of this type will be the best guide in obtaining the desired information, and a consideration of synonymous or closely related terms will prove valuable.

Information must be so indexed as to be of the greatest use to the greatest number of users. This requires that a topic be indexed to headings that most specifically describe it and not ordinarily to the headings that describe its ultimate use, nor to the general class headings that include the specific headings. For example, information on the treatment of thyroid disease with I-131 would be indexed under Thyroid Diseases and under Iodine Isotopes I-131, but not necessarily under Radiotherapy. A study of the effects of x radiation on hair would be indexed under both X Radiation and Hair.

The broad, general class headings are used only for general information or for comprehensive reports or articles.

Subject Heading Styles

Generally, the direct form of subject entry is used rather than inverted headings or, in some cases, subheadings; e.g., Amino Acids rather than Acids, amino; Helium Isotopes He-4 rather than Helium — isotopes He-4 or Helium — He-4 isotopes. Note, however, that in some cases modifying terms are used parenthetically in preference to a more direct type of entry which would result in the scattering of information. Organic compounds, however, are usually entered in the index in the inverted form so that substituted compounds can be listed near the parent compound; e.g., Benzene, Bromo- rather than Bromobenzene. In general, the style of nomenclature used is that of *Chemical Abstracts*, except that some items listed in that publication as subheadings are elevated to form part of the main heading; e.g., Butyric Acid, Methyl Ester rather than Butyric Acid — methyl ester.

Alphabetization

Main headings are arranged according to the widely accepted word-by-word alphabetic system. A parenthetic qualifier following a main heading is disregarded in alphabetizing unless there are two or more headings identical except for the parenthetic qualifier, in which case the qualifier determines the order. Headings involving Greek letters are arranged as if the names of the letters were spelled out, e.g., Mesons (π), Mesons (ζ).

Nomenclature of Inorganic Compounds

Inorganic compounds are indexed in the direct form, listing cations in the order of increasing valence in the case of polycationic salts of varying valence and in alphabetic order for polycationic salts in which all cations have the same valence; e.g., Sodium Aluminum Silicates and Potassium Sodium Sulfates.

Multicomponent Systems

Multicomponent alloys, except well-known trade names are indexed under each element in the alloy.

Example: Aluminum–Chromium Alloys are indexed

ALUMINUM ALLOYS
Al–Cr ...
CHROMIUM ALLOYS
Al–Cr ...

Well-known alloys such as Hastelloy are indexed directly. Cross references appear in the index cumulations. Multicomponent systems of elements are indexed similarly.

Example: Silicon–Tungsten Systems are indexed

SILICON SYSTEMS
Si–W ...
TUNGSTEN SYSTEMS
Si–W ...

Multicomponent systems of compounds are similarly indexed under the compound.

Physical States of Materials

Specification of the physical state of the material, if other than normal, is included in the modifying phrase.

Modifying Phrases (Subheadings)

Whenever it appears that such information would be useful, descriptive phrases (modifiers), rather than ordinary subheadings, are used under the main headings to give a better indication of the material covered in an abstract. Such phrases are written so that the idea considered most important is presented first. However, when using this index, the reader is advised to scan all modifiers under a main heading to determine whether any abstracts in addition to the most obvious should be consulted for the desired information. Many of the modifiers are designed to be read in inverted order or to be read with the main heading inserted at the position of the comma in order to obtain a meaningful phrase; e.g., Uranium — allotropic transformation temperatures of, effect of cooling rate on is read "effect of cooling rate on allotropic transformation temperatures of uranium." In many cases, the prepositions have been omitted from such phrases provided no ambiguity results from the omission.

For entries concerned with physics, if the modifier does not indicate whether the reference is experimental or theoretical, a symbol E or T or E/T is given.

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186-1	19-1926	
186-2	19-1047	

Report No.	Abstract No.	Availability
GA-	**(Misc.)**	
4413	19-1876	Dep.(mn); $5.00(cy), 3(mn) OTS
5620	19-952	Dep.(mn); $1.00(cy), 1(mn) OTS
GAMD-	**(Misc.)**	
2251	19-1877	Dep.(mn); $2.00(cy), 1(mn) OTS
3611	19-1878	Dep.(mn); $3.00(cy), 1(mn) OTS
GEAP-	**(Misc.)**	
4356	19-1879	Dep.(mn); $2.00(cy), 1(mn) OTS
4446	19-953	Dep.(mn); $3.00(cy), 2(mn) OTS
4452	19-994	Dep.(mn); $2.00(cy), 1(mn) OTS
4621	19-1853	Dep.(mn); $2.00(cy), 1(mn) OTS
4634	19-581	Dep.(mn); $3.00(cy), 2(mn) OTS
4643	19-761	Dep.; $1.00(cy), 1(mn) OTS
GEMP-	**(Misc.)**	
38A	19-894	Dep.; $2.00(cy), 1(mn) OTS
HNS-		
50	19-619	Dep.(mn); $3.00(cy), 2(mn) OTS
55	19-1032	Dep.(mn); $2.00(cy), 1(mn) OTS
1229-54	19-679	Dep.(mn); $3.00(cy), 2(mn) OTS
HW-		
67349	19-680	Dep.(mn); $1.00(cy), 1(mn) OTS
68302	19-722	$1.00(cy), 1(mn) OTS)
68600-43	19-1954	Dep.; $1.00(cy), 1(mn) OTS
69876	19-922	Dep.(mn); $1.00(cy), 1(mn) OTS
74293	19-723	Dep.(mn); $1.00(cy), 1(mn) OTS
78146	19-724	Dep.(mn); $1.00(cy), 1(mn) OTS
79125	19-762	Dep.(mn); $1.00(cy), 1(mn) OTS
80841	19-954	Dep.; $2.00(cy), 1(mn) OTS
81173	19-870	Dep.(mn); $1.00(cy), 1(mn) OTS
81746	19-1	Dep.; $7.00(cy), 6(mn) OTS
82400	19-895	Dep., $4.00(cy), 3(mn) OTS
82888	19-1933	Dep.(mn); $1.00(cy), 1(mn) OTS
83386	19-897	Dep.; $2.00(cy), 1(mn) OTS
83427	19-769	Dep.; $2.00(cy), 1(mn) OTS
83577	19-1855	Dep.(mn); $3.00(cy), 2(mn) OTS
83801	19-1955	Dep.(mn); $1.00(cy), 1(mn) OTS
HW-SA-		
2179	19-450	J. Polymer Sci., Pt. A, 2: 4965-71(1964)
3031	19-527	See HW-81746(p.4.5-11)
3054	19-341	See HW-81746(p.4.12-15)
3064	19-425	See HW-81746(p.3.105-7)
3229	19-1033	See HW-81746(p.1.1-19)
3267	19-528	See HW-81746(p.4.15-23)
3323	19-26	See HW-81746(p.2.12-16)
3550	19-689	Dep.(mn); $1.00(cy), 1(mn) OTS; Gmelin, AED-CONF-64-082-11
3641	19-32	Dep.(mn); $1.00(cy), 1(mn) OTS
3689	19-623	Dep.(mn); $1.00(cy), 1(mn) OTS
3721	19-287	Dep.(mn); $1.00(cy), 1(mn) OTS
3738	19-898	Dep.(mn); $1.00(cy), 1(mn) OTS
IA-	**(Non-AEC)**	
911	19-1521	Dep.(mn)
936	19-1522	Dep.(mn)
949	19-518	Dep.(mn)
IAEA-R-	**(Dutch)**	
18	19-70	Dep.(mn)
IDO-		
12035	19-624	Dep.; $3.00(cy), 2(mn) OTS
16975	19-725	Dep.; $1.00(cy), 1(mn) OTS
16994	19-1956	Dep.; $3.00(cy), 1(mn) OTS
28634	19-1880	Dep.; $5.00(cy), 4(mn) OTS
IFA-IS-	**(Rumanian)**	
M-35	19-1166	Dep.(mn)
IITRI-	**(Misc.)**	
528-19	19-556	Dep.; $4.00(cy), 2(mn) OTS
578P22-11	19-1825	Dep.(mn); $2.00(cy), 1(mn) OTS
IMSJ-	**(Japanese)**	
78	19-770	Dep.(mn)

Report No.	Abstract No.	Availability
IPPJ-	**(Japanese)**	
21	19-1700	Dep.(mn)
28	19-1701	Dep.(mn)
IS-		
757	19-955	Dep.; $3.00(cy), 2(mn) OTS
827	19-277	Dep.; $5.00(cy), 4(mn) OTS
892	19-1263	Phys. Rev., 136: B719-22(1964)
919	19-1245	J. Math. Phys. (N. Y.), 5: 1645-51(1964)
JAERI-	**(Japanese)**	
1058	19-1523	Dep.(mn)
1059	19-690	
1060	19-1934	
1063	19-1093	
1064	19-726	
6014	19-1094	
6015	19-1048	Dep.(mn)
JINR-	**(Russian)**	
D-1799	19-1549	Dep.(mn)
E-1817	19-1225	Dep.(mn)
P-1716	19-1550	Dep.(mn)
P-1725	19-1551	Dep.(mn)
P-1728	19-1552	Dep.(mn)
P-1731	19-1226	Dep.(mn)
P-1738	19-1095	Dep.(mn)
P-1739	19-871	Dep.(mn)
P-1741	19-1227	Dep.(mn)
P-1742	19-1228	Dep.(mn)
P-1743	19-1553	Dep.(mn)
P-1745	19-1554	Dep.(mn)
P-1780	19-1229	Dep.(mn)
P-1791	19-1230	Dep.(mn)
P-1797	19-1524	Dep.(mn)
P-1810	19-771	Dep.(mn)
JPL-TR-	**(Non-AEC)**	
32-627	19-1702	
JPRS-	**(Non-AEC)**	
25966	19-1982	$3.00(OTS)
26500	19-216	$3.00(OTS)
26532	19-77	$4.00(OTS)
26542	19-7	$1.00(OTS)
26692	19-8	$3.00(OTS)
26725	19-9	$2.00(OTS)
26757	19-10	$1.00(OTS)
26808	19-1895	$5.00(OTS)
26842	19-188	$2.00(OTS)
26877	19-355	$2.00(OTS)
26960	19-79	$2.00(OTS)
27006	19-223	$1.00(OTS)
JüL-	**(German)**	
170-PC	19-1208	Dep.(mn)
K-		
1619	19-1203	Dep.; $2.00(cy), 1(mn) OTS
KAPL-		
2165-3	19-1525	Dep.(mn); $3.00(cy), 1(mn) OTS
3060	19-927	Dep.(mn); $1.00(cy), 1(mn) OTS
KAPL-M-		
6194	19-872	Dep.(mn); $1.00(cy), 1(mn) OTS
KR-	**(Norwegian)**	
70	19-1893	See TID-21251
LA-		
3106(Vol.I)	19-873	Dep.; $7.42(OTS)
3109	19-567	Dep.; $2.00(cy), 1(mn) OTS
3123	19-288	Dep.; $1.00(cy), 1(mn) OTS
3124	19-289	Dep.; $1.00(cy), 1(mn) OTS
3125	19-290	Dep.; $1.00(cy), 1(mn) OTS
3134	19-291	Dep.; $1.00(cy), 1(mn) OTS
3140-MS	19-956	Dep.; $2.00(cy), 1(mn) OTS
LA-DC-		
6468	19-899	Dep.(mn); $1.00(cy), 1(mn) OTS

Report No.	Abstract No.	Availability
6491	19-1231	Dep.(mn); $1.00(cy), 1(mn) OTS
6570	19-856	Dep.(mn); $1.00(cy), 1(mn) OTS
6608	19-1881	Dep.(mn); $1.00(cy), 1(mn) OTS
LADC–		
6450	19-1493	Phys. Rev., 136: A918-26(1964)
LAL–	**(French)**	
1104	19-772	Dep.(mn)
1114	19-773	
LAMS–		
2878	19-625	Dep.; $1.00(cy), 1(mn) OTS
2985	19-1049	Dep.(mn); $4.00(cy), 3(mn) OTS
3074	19-774	Dep.(mn); $3.00(cy), 2(mn) OTS
LF–		
17	19-71	Dep.; $1.00(cy), 1(mn) OTS
LNF–	**(Italian)**	
64/17	19-727	Dep.(mn)
64/26	19-1232	Dep.(mn)
MATT–		
239	19-1703	Dep.(mn); $3.00(cy), 2(mn) OTS; Gmelin, AED-CONF-63-268-34
291	19-1704	Dep.(mn); $1.00(cy), 1(mn) OTS
MCW–		
1487	19-957	Dep.; $2.00(cy), 1(mn) OTS
MIT–	**(Misc.)**	
905-17	19-1628	Phys. Rev., 136: B603-17(1964)
905-19	19-1555	Dep.(mn); $1.00(cy), 1(mn) OTS
2098-50	19-832	Rev. Sci. Instr., 35: 1642-6(1964)
2098-74	19-1556	Dep.(mn); $3.00(cy), 2(mn) OTS
2098-77	19-1192	Dep.(mn); $1.00(cy), 1(mn) OTS
2098-79	19-1233	Dep.(mn); $1.00(cy), 1(mn) OTS
MITNE–	**(Misc.)**	
47	19-775	$4.00(OTS)
ML–	**(Misc.)**	
1200	19-1705	
ML-TDR–	**(Non-AEC)**	
64-125(Vol.II)	19-900	OTS
MLM–		
1191	19-344	Dep.; $2.00(cy), 1(mn) OTS
1193	19-937	Dep.; $1.00(cy), 1(mn) OTS
1194	19-938	Dep.; $1.00(OTS)
MMPP-NPC–		
1962-1	19-1541	Lectures from the Second Neutron Physics Conference, Boyne Mountain, Michigan, June, 1962. Ann Arbor, Mich., Michigan Memorial-Phoenix Project, 1964.
MND–	**(Misc.)**	
2812-5	19-1209	Dep.(mn); $2.00(cy), 1(mn) OTS
MSAR–	**(Misc.)**	
64-102	19-901	Dep.(mn); $2.00(cy), 1(mn) OTS
64-112	19-928	Dep.(mn); $1.00(cy), 1(mn) OTS
N–	**(Misc.)**	
64-17352	19-1706	See NASA-CR-53229
64-17353	19-1707	See NASA-CR-53229(p.15-22)
64-17354	19-1708	See NASA-CR-53229(p.23-30)
64-17355	19-1709	See NASA-CR-53229(p.31-8)
64-28163	19-1096	See NASA-CR-56934
64-28167	19-1096	See NASA-CR-56934
64-29236	19-1699	See ARC-CP-743
NAA-SR–		
5128	19-415	Dep.; $2.00(cy), 1(mn) OTS
7892	19-1839	Dep.; $2.00(cy), 1(mn) OTS
9161	19-345	Dep.; $2.00(cy), 1(mn) OTS
9260	19-958	Dep.; $1.00(cy), 1(mn) OTS
9278	19-531	Dep.; $2.00(cy), 1(mn) OTS
9734	19-292	Dep.; $1.00(cy), 1(mn) OTS
9777(Vol.I)	19-1882	Dep.(mn); $6.00(cy), 4(mn) OTS
9777(Vol.II)	19-1883	Dep.(mn); $7.00(cy), 6(mn) OTS
9777(Vol.III)	19-1884	Dep.(mn); $7.00(cy), 6(mn) OTS
9777(Vol.IV)	19-1885	Dep.(mn); $7.00(cy), 5(mn) OTS
9777(Vol.V)	19-1886	Dep.(mn); $6.00(cy), 5(mn) OTS
9777(Vol.VI)	19-1887	Dep.(mn); $7.00(cy), 5(mn) OTS
9799	19-1888	Dep.; $5.00(cy), 3(mn) OTS
9982	19-642	Dep.; $3.00(cy), 2(mn) OTS
NAA-SR-Memo–		
5397	19-1840	Dep.(mn); $1.00(cy), 1(mn) OTS
NASA-CR–	**(Misc.)**	
53229	19-1706	$2.60(ph) OTS
54003	19-1925	See FZK-182
54050	19-582	
54078	19-1926	See FZK-186-1
56934	19-1096	$21.00(OTS)
NASA-TN–	**(Misc.)**	
D-2153	19-293	$0.50(OTS)
D-2155	19-1710	$0.75(OTS)
D-2156	19-1479	$0.50(OTS)
D-2164	19-1711	$1.25(OTS)
D-2211	19-1712	$0.75(OTS)
NLCO–		
914	19-294	Dep.; $3.00(cy), 2(mn) OTS
917	19-295	Dep.; $2.00(cy), 1(mn) OTS
930	19-296	Dep.; $1.00(cy), 1(mn) OTS
NMI–	**(Misc.)**	
4802	19-939	Dep.(mn); $1.00(cy), 1(mn) OTS
NORA–	**(Norwegian)**	
8	19-1893	See TID-21251
NP–	**(AEC File No. for Non-AEC Reports)**	
14297	19-1557	Dep.(mn)
14332	19-776	
14337	19-1713	Dep.(mn)
14365(Pt.B)	19-1889	Dep.(mn); $6.00(cy), 5(mn) OTS
14375	19-72	$0.75(OTS)
14380	19-626	Dep.(mn)
14394	19-691	
14397	19-1405	Dep.(mn)
14398	19-1714	Dep.(mn)
14399	19-1406	
14400	19-1407	Dep.(mn)
14402	19-1715	Dep.(mn)
14403	19-1408	
14404	19-1050	
14405	19-1426	Dep.(mn)
14406	19-1480	Dep.(mn)
14407	19-692	Dep.(mn)
14417	19-1560	Dep.(mn)
14423	19-1716	Dep.(mn)
14430	19-1561	Dep.(mn)
14431	19-583	
14434	19-929	
14436	19-1467	
14438	19-1717	
14440	19-584	
14441	19-585	
14442	19-1718	
NRL–	**(Misc.)**	
6145	19-777	Dep.(mn); $2.00(cy), 1(mn) OTS
NRL-Memo–	**(Misc.)**	
1351	19-996	Dep.(mn); $1.00(cy), 1(mn) OTS
NYO–		
1480-4	19-874	Dep.(mn); $3.00(cy), 1(mn) OTS
1480-6	19-1957	Dep.(mn); $3.00(cy), 2(mn) OTS
2391-2	19-1481	Dep.(mn); $3.00(cy), 2(mn) OTS
2391-3	19-1051	Dep.(mn); $1.00(cy), 1(mn) OTS
2391-4	19-1482	Dep.(mn); $1.00(cy), 1(mn) OTS

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2391-5	19-1483	Dep.(mn); $1.00(cy), 1(mn) OTS
2471-3	19-1958	Dep.(mn); $4.00(cy), 3(mn) OTS
2669-1	19-416	Dep.(mn); $1.00(cy), 1(mn) OTS
2814-1	19-73	Dep.(mn); $1.00(cy), 1(mn) OTS
2994-1	19-997	Dep.(mn); $1.00(cy), 1(mn) OTS
3039-1	19-33	Dep.(mn); $1.00(cy), 1(mn) OTS
3304-2	19-586	Dep.(mn); $3.00(cy), 2(mn) OTS
10533	19-627	Dep.(mn); $5.00(cy), 4(mn) OTS
ORA–	**(Misc.)**	
06110-1-T	19-584	See NP-14440
ORNL–		
3676	19-1052	Dep.; $6.00(cy), 4(mn) OTS
3679	19-278	Dep.; $4.00(cy), 3(mn) OTS
3682	19-1959	Dep.; $2.00(cy), 1(mn) OTS
3696	19-1719	Dep.; $4.00(cy), 3(mn) OTS
3699	19-779	Dep.; $1.00(cy), 1(mn) OTS
3715	19-1526	Dep.; $2.00(cy), 1(mn) OTS
ORNL-P–		
41	19-1629	Phys. Rev., 136: B618-24(1964)
62	19-1631	Phys. Rev., 136: B637-47(1964)
98	19-1636	Phys. Rev., 136: B695-703(1964)
121	19-326	Microchem. J., 8: 234-40(1964)
499	19-963	Dep.(mn); $1.00(cy), 1(mn) OTS
514	19-1563	Dep.(mn); $1.00(cy), 1(mn) OTS
517	19-1960	Dep.(mn); $1.00(cy), 1(mn) OTS
532	19-729	Dep.(mn); $1.00(cy), 1(mn) OTS
539	19-300	Dep.(mn); $1.00(cy), 1(mn) OTS
542	19-349	Dep.(mn); $1.00(cy), 1(mn) OTS
548	19-780	Dep.(mn); $1.00(cy), 1(mn) OTS
556	19-1005	Dep.(mn); $1.00(cy), 1(mn) OTS
573	19-350	Dep.(mn); $1.00(cy), 1(mn) OTS
586	19-1961	Dep.(mn); $1.00(cy), 1(mn) OTS
591	19-430	Dep.(mn); $1.00(cy), 1(mn) OTS
594	19-1962	Dep.(mn); $2.00(cy), 1(mn) OTS
605	19-1946	Dep.(mn); $1.00(cy), 1(mn) OTS
ORNL-TM–		
817	19-1813	Dep.(mn); $3.00(cy), 1(mn) OTS
938	19-1564	Dep.(mn); $3.00(cy), 2(mn) OTS
953	19-1814	Dep.(mn); $1.00(cy), 1(mn) OTS
958	19-1427	Dep.(mn); $1.00(cy), 1(mn) OTS
964	19-1565	Dep.(mn); $1.00(cy), 1(mn) OTS
974	19-1527	Dep.(mn); $1.00(cy), 1(mn) OTS
ORNL-tr–		
201	19-358	Dep.(mn); $5.60(fs), $1.82(mf) JCL
335	19-866	Dep.(mn); $1.10(fs), $0.80(mf) JCL
ORO–		
620	19-21	Dep.; $4.00(cy), 2(mn) OTS
PAEC(D)RE–	**(Philippines)**	
647	19-1935	Dep.(mn)
648	19-1936	Dep.(mn)
649	19-1937	Dep.(mn)
PAN–	**(Polish)**	
347	19-1234	Dep.
498/VI	19-1193	Dep. Acta Phys. Polon., 26: 71-6(1964)
507/VI	19-1194	Dep. Nukleonika, 9: 379-83(1964)
516/II	19-781	Dep.(mn)
PATENTS	**(German)**	
1,167,458	19-1859	
1,167,459	19-1819	
1,167,463	19-1135	
1,167,503	19-573	
1,167,797	19-553	
1,168,087	19-412	
1,168,395	19-413	
1,168,400	19-414	
1,168,575	19-842	
1,168,576	19-1829	
1,168,580	19-1136	
1,169,041	19-843	
1,169,046	19-1830	
1,169,597	19-1831	
1,171,094	19-844	
1,171,541	19-845	
1,171,542	19-846	
1,171,543	19-847	
1,171,545	19-715	
PATENTS	**(Japanese)**	
19252/1963	19-866	For translation see ORNL-tr-335
PATENTS	**(U. S.)**	
3,152,862	19-554	
3,152,958	19-1811	
3,152,961	19-517	
3,152,962	19-1921	
3,152,963	19-1860	
3,152,964	19-1861	
3,152,965	19-1832	
PATENTS	**(U.S.S.R.)**	
162,258	19-574	
162,405	19-935	
PDL–	**(Non-AEC)**	
42277	19-74	OTS
42574	19-857	$1.10(OTS)
46195	19-1006	$1.10(OTS)
PG-Report–	**(British)**	
604	19-607	Dep.(mn); $2.00(BIS); 10s. (HMSO)
PNE–		
112F(Pt.II)	19-608	Dep.; $2.00(cy), 1(mn) OTS
112F(Pt.III)	19-281	Dep.; $2.00(OTS)
236F	19-34	Dep.; $3.00(cy), 1(mn) OTS
240-F	19-563	Dep.; $2.00(OTS)
241F	19-628	Dep.; $3.00(cy), 1(mn) OTS
3001	19-609	Dep.; $2.00(cy), 3(mn) OTS
5001P	19-610	Dep.; $4.00(cy), 3(mn) OTS
PPAD–		
521-F	19-1235	Dep.(mn); $3.00(cy), 2(mn) OTS
526-D	19-1123	Dep.(mn); $1.00(cy), 1(mn) OTS
PR-P–	**(Canadian)**	
62	19-1053	Dep.; $1.50(AECL)
PUC–		
1964-142	19-1130	Rev. Sci. Instr., 35: 1653-7(1964)
1964-153	19-1054	Dep.(mn); $4.00(cy), 2(mn) OTS
1964-154	19-1566	Dep.(mn); $1.00(cy), 1(mn) OTS
R–	**(Misc.)**	
2289	19-526	See EURAEC-1069
64SD61	19-1720	
RFP–		
428	19-902	Dep.; $1.00(cy), 1(mn) OTS
436	19-282	Dep.; $5.00(cy), 3(mn) OTS
RFR–	**(Swedish)**	
223	19-1567	Dep.(mn)
RISÖ–	**(Danish)**	
82	19-1428	Dep.(mn); Jul. Gjellerup, 87, Sölvgade, Copenhagen K, Denmark
83	19-1007	Dep.(mn); Jul. Gjellerup, 87, Sölvgade, Copenhagen K, Denmark
RRA–	**(Misc.)**	
M44	19-1815	Dep.(mn); $2.00(cy), 1(mn) OTS
RT-CHI–	**(Italian)**	
(64)-6	19-532	Dep.(mn)
(64)-10	19-301	Dep.
(64)-11	19-302	Dep.
(64)-13	19-303	Dep.
(64)-14	19-351	Dep.(mn)

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RT-FI-	**(Italian)**	
(64)-8	19-1721	Dep.(mn)
(64)-13	19-1722	Dep.(mn)
S-	**(Misc.)**	
248-R	19-750	See AD-601323
325	19-626	See NP-14380
SAH-		
1008	19-587	Dep.(mn); $5.00(cy), 3(mn) OTS
SC-	**(Misc.)**	
4741(RR)	19-648	Dep.(mn); $4.00(cy), 2(mn) OTS
SC-DC-		
64-491	19-1963	Dep.(mn); $3.00(cy), 1(mn) OTS
64-1509	19-557	Dep.(mn); $1.00(cy), 1(mn) OTS
SC-DR-		
64-645	19-1964	Dep.(mn); $2.00(cy), 1(mn) OTS
SC-R-		
64-1301	19-863	Dep.(mn); $1.00(cy), 1(mn) OTS
SC-RR-		
64-502	19-1927	Dep.; $4.00(cy), 1(mn) OTS
64-530	19-558	Dep.(mn); $2.00(cy), 1(mn) OTS
64-1207	19-1055	Dep.(mn); $1.00(cy), 1(mn) OTS
SC-TM-		
64-670	19-1965	Dep.(mn); $2.00(cy), 1(mn) OTS
64-984	19-1966	Dep.(mn); $2.00(cy), 2(mn) OTS
357-63(13)	19-964	Dep.(mn); $2.00(cy), 1(mn) OTS
SCL-DC-		
64-83	19-1967	Dep.(mn); $1.00(cy), 1(mn) OTS
SGAE-PH-	**(Austrian)**	
5/1964	19-782	Dep.(mn)
SL-	**(Misc.)**	
2158	19-1890	Dep.(mn); $2.00(cy), 1(mn) OTS
SLAC-PUB-		
28	19-1273	Phys. Rev., 136: B787-803(1964)
SRIA-		
128	19-903	Dep.(mn); $1.00(cy), 1(mn) OTS
SWRHL-		
5r	19-697	See VUF-1009
SWRI-		
1228-31	19-904	Dep.(mn); $2.00(cy), 1(mn) OTS
1228-37	19-905	Dep.(mn); $2.00(cy), 1(mn) OTS
1228-38	19-905	See SWRI-1228-37
1228-39	19-905	See SWRI-1228-37
TDVI-	**(Canadian)**	
40	19-1826	Dep.; $1.00(AECL)
THAI-AEC-	**(Thailand)**	
1	19-693	Dep.(mn)
TID-		
4100(Suppl.24)	19-559	Dep.; Free(DTI Extension)
7696	19-304	Dep.; $6.00(cy), 6(mn) OTS
18555	19-560	Dep.(mn); $1.00(cy), 1(mn) OTS
19521	19-1846	Nucl. Sci. Eng., 20: 414-27(1964)
19796	19-41	Crop Sci., 4: 154-6(1964)
20202	19-1847	Nucl. Sci. Eng., 20: 428-35(1964)
20441(Vol.I)	19-1968	Dep.(mn); $6.00(cy), 4(mn) OTS
20752	19-1602	Nucl. Phys., 61: 209-18(1965)
20894	19-568	Dep.(mn); $3.00(cy), 2(mn) OTS
21113	19-1568	Dep.(mn); $1.00(cy), 1(mn) OTS
21114	19-906	Dep.(mn); $1.00(cy), 1(mn) OTS
21117	19-75	Dep.(mn); $2.00(cy), 1(mn) OTS
21121	19-431	Dep.(mn); $2.00(cy), 1(mn) OTS
21129	19-1891	Dep.(mn); $3.00(cy), 2(mn) OTS
21194	19-783	Dep.(mn); $2.00(cy), 2(mn) OTS
21195	19-1569	Dep.(mn); $2.00(cy), 1(mn) OTS
21196	19-1816	Dep.(mn); $3.00(cy), 2(mn) OTS
21201	19-1570	Dep.(mn); $3.00(cy), 2(mn) OTS
21206	19-630	Dep.(mn); $2.00(cy), 1(mn) OTS
21218	19-965	Dep.(mn); $1.00(cy), 1(mn) OTS
21221	19-1969	$5.00(cy), 3(mn) OTS
21230	19-1970	Dep.(mn); $1.00(cy), 1(mn) OTS
21231	19-1892	Dep.(mn); $3.00(cy), 2(mn) OTS
21234	19-784	Dep.(mn); $3.00(cy), 1(mn) OTS
21236	19-432	Dep.(mn); $4.00(cy), 3(mn) OTS
21239	19-695	Dep.(mn); $1.00(cy), 1(mn) OTS
21241	19-631	Dep.(mn); $1.00(cy), 1(mn) OTS
21246	19-569	Dep.(mn); $5.00(cy), 3(mn) OTS
21247	19-1571	Dep.(mn); $4.00(cy), 2(mn) OTS
21249	19-908	Dep.(mn); $1.00(cy), 1(mn) OTS
21250	19-433	Dep.(mn); $3.00(cy), 2(mn) OTS
21251	19-1893	Dep.(mn); $2.00(cy), 1(mn) OTS
21279	19-632	Dep.(mn); $1.00(cy), 1(mn) OTS
TT-	**(Canadian)**	
64-41237	19-1982	See JPRS-25966
64-41758	19-216	See JPRS-26500
64-41790	19-77	See JPRS-26532
64-41800	19-7	See JPRS-26542
64-41949	19-8	See JPRS-26692
64-41982	19-9	See JPRS-26725
64-51014	19-10	See JPRS-26757
64-51065	19-1895	See JPRS-26808
64-51099	19-188	See JPRS-26842
64-51134	19-355	See JPRS-26877
64-51216	19-79	See JPRS-26960
64-51262	19-223	See JPRS-27006
UCRL-		
3307(Rev.2)	19-785	Dep.(mn); $5.00(cy), 4(mn) OTS
7438	19-1971	Dep.; $1.00(cy), 1(mn) OTS
7662	19-1590	Nucl. Phys., 61: 17-24(1965)
7744	19-1059	J. Appl. Phys., 35: 3337-43(1964)
7833	19-967	Dep.; $2.00(cy), 1(mn) OTS
7854-T	19-1259	Phys. Rev., 136: B624-30(1964)
7902(Rev.1)	19-730	Dep.(mn); $1.00(cy), 1(mn) OTS
7964	19-561	Dep.; $2.00(cy), 1(mn) OTS
7973	19-1972	Dep.; $2.00(cy), 1(mn) OTS
7992	19-731	Dep.; $1.00(cy), 1(mn) OTS
11013	19-1625	Phys. Rev., 136: B584-9(1964)
11204	19-1195	Dep.(mn); $1.00(cy), 1(mn) OTS; Gmelin, AED-CONF-64-044-61
11211	19-1973	Dep.(mn); $1.00(cy), 1(mn) OTS; Gmelin, AED-CONF-64-028-26
11222	19-875	Dep.; $3.00(cy), 2(mn) OTS
11303	19-811	Nucl. Instr. Methods, 30: 261-7(1964)
11343	19-311	Anal. Biochem., 9: 343-50(1964)
11363	19-876	Dep.; $2.00(cy), 1(mn) OTS
11374	19-1974	Dep.(mn); $3.00(cy), 2(mn) OTS
11383	19-1124	Dep.; $1.00(cy), 1(mn) OTS
11384	19-786	Dep.; $2.00(cy), 1(mn) OTS
11387(Suppl.)	19-5	Dep.; $3.00(cy), 1(mn) OTS
11462	19-1624	Phys. Rev., 136: B577-83(1964)
11463	19-1261	Phys. Rev., 136: B710-13(1964)
11541	19-1429	Dep.(mn); $3.00(cy), 2(mn) OTS
11542	19-1975	Dep.(mn); $1.00(cy), 1(mn) OTS
11581	19-1976	Dep.(mn); $1.00(cy), 1(mn) OTS
11584	19-352	Dep.(mn); $4.00(cy), 3(mn) OTS
11620	19-787	Dep.; $1.00(cy), 1(mn) OTS
11622	19-1236	Dep.; $1.00(cy), 1(mn) OTS
11629	19-589	Dep.(mn); $6.00(cy), 4(mn) OTS
11645	19-353	Dep.; $1.00(cy), 1(mn) OTS
11663	19-1572	Dep.(mn); $4.00(cy), 3(mn) OTS
11679	19-1430	Dep.(mn); $4.00(cy), 3(mn) OTS
12029-T	19-968	Dep.(mn); $1.00(cy), 1(mn) OTS
12039	19-969	Dep.; $4.00(cy), 3(mn) OTS
12051-T	19-354	Dep.(mn); $1.00(cy), 1(mn) OTS
13121	19-1928	Dep.(mn); $2.00(cy), 1(mn) OTS
UCRL-Trans-		
1117(L)	19-359	Dep.(mn); $3.60(fs), $1.22(mf) JCL
UJV-	**(Czechoslovakian)**	
1006/64	19-307	Dep.(mn)
1054/64	19-732	Dep.(mn)

Report No.	Abstract No.	Availability
1101/64	19-1573	Dep.(mn)
1114/64	19-696	Dep.(mc)
DMC-	**(Misc.)**	
5086	19-1817	
5096	19-909	Dep.(mn); $2.00(cy), 1(mn) OTS
IR-		
652	19-1977	Dep.; $2.00(cy), 1(mn) OTS
175-41	19-1277	Phys. Rev., 136: B816-29(1964)
USAELRDL-TR-	**(Non-AEC)**	
2397	19-788	$1.00(OTS)
USNRDL-TR-	**(Misc.)**	
769	19-436	Dep.(mn); $1.00(cy), 1(mn) OTS
VUF-		
1009	19-697	Dep.; $2.00(cy), 1(mn) OTS
1010	19-1978	Dep.; $4.00(OTS)
1012	19-698	Dep.; $2.00(cy), 1(mn) OTS
1015	19-1979	Dep.; $6.00(OTS)
1016	19-562	Dep.; $2.00(cy), 1(mn) OTS
1017	19-1980	Dep.; $1.00(OTS)
WAPD-T-		
1628(Rev.)	19-1533	Nucl. Sci. Eng., 20: 455-61(1964)
1688	19-570	Dep.(mn); $1.00(cy), 1(mn) OTS
1742	19-733	Dep.(mn); $2.00(cy), 1(mn) OTS
WAPD-TM-	**(Misc.)**	
433	19-1894	Dep.; $1.00(cy), 1(mn) OTS
WIS-TCI-	**(Misc.)**	
67	19-1170	Dep.(mn); $2.00(cy), 1(mn) OTS
WW-	**(Dutch)**	
016-R-69	19-580	See EURAEC-1123
Y-		
1468	19-940	Dep.; $2.00(cy), 1(mn) OTS
Y-IA-		
7	19-1981	Dep.(mn); $1.00(cy), 1(mn) OTS

Appendix I

NUCLEAR SCIENCE ABSTRACTS CATEGORY DEFINITIONS

BIOLOGY AND MEDICINE

General

Information applicable to the main subject category but which is outside specific subcategories or is a combination of three or more subcategories.

Ecology

Studies of the movement of radioactive and other materials through organisms and the environment and influence of these materials on natural communities. The measurement and hazards of radioactive materials in the biosphere are included in the subcategory *Radiation Hazards and Protection* of this category.

Metabolism, Tissue Distribution, and Toxicology

Chemical and metabolic processes in living organisms and the absorption, metabolism, utilization, and toxicological significance of materials ingested, inhaled, or otherwise entering the organisms. Studies performed to establish maximum allowable concentrations of radioactive materials are included in the subcategory *Radiation Hazards and Protection* of this category.

Radiation Effects

Information on the effects of radiation on organisms or their components, including radiation sickness.

Radiation Effects Therapy and Countermeasures

Use of biological extracts, chemical compounds, or drugs to alter, prevent, simulate, or treat the effects of radiation on organisms or their components. The use of special shields to prevent radiation effects is included in the subcategory *Radiation Hazards and Protection* of this category.

Radiation Hazards and Protection

Measurement and hazards of radioactive material in the biosphere; studies of maximum permissible concentrations of radioactive materials on organisms or their components; and the use of rules, procedures, and equipment to reduce radiation exposure. Users of this subcategory should also see the subject category HEALTH AND SAFETY.

Radiotherapy and Radiodiagnosis

Use of both external and internal radiation sources in the diagnosis and therapy of disease. Also includes all phases of radiation equipment, procedure, and effectiveness. For radiation side effects, see the subcategory *Radiation Effects* of this category.

CHEMISTRY

This category excludes *biochemistry*, which is found in the category BIOLOGY AND MEDICINE; *corrosion* which is a subcategory of METALS, CERAMICS, AND OTHER MATERIALS; and *geochemistry* which is included in the category GEOLOGY AND MINERALOGY.

General

Information applicable to the main subject category but which is outside specific subcategories or is a combination of three or more subcategories.

Analytical Procedures

Qualitative and quantitative procedures, radiochemical analysis, neutron-activation analysis, and mass spectroscopy.

Inorganic and Physical Chemistry

Chemistry of elements and inorganic compounds and chemical thermodynamics. Chemistry of elements and inorganic compounds is also included in the subcategories *Analytical Procedures*, *Radiation Chemistry*, *Radiochemistry*, and *Separation Processes and Procedures* of this category and in the category METALS, CERAMICS, AND OTHER MATERIALS. Radiation effects on chemical properties and reactions are included in the subcategory *Radiation Chemistry* of this category.

Organic Chemistry

Chemical and physical properties and reactions of organic compounds and systems of compounds. Equipment and procedures for investigating such properties and reactions are also included. For radiation effects on organic compounds, see the subcategory *Radiation Chemistry* of this category. Also see the subcategory *Separation Processes and Procedures* of this category.

Radiation Chemistry

Radiation effects on chemical properties and reactions, radiation effects on physical properties of nonmetallic elements and compounds and organic compounds. Also includes the generation of visible light as a result of radiation. Radiation effects on biological materials are included in the subcategory *Radiation Effects* of the category BIOLOGY AND MEDICINE. Radiation effects on metals and intermetallic compounds are included in the category METALS, CERAMICS, AND OTHER MATERIALS.

Radiochemistry

Chemistry of radioactive materials and special chemical procedures and equipment required as a result of the presence of radiation. See also the subcategory *Separation processes and procedures* of this category and the category WASTE DISPOSAL AND PROCESSING.

Separation Processes and Procedures

Chemistry and chemical engineering for processing uranium and thorium ores and reactor fuel and breeder materials. Also includes chemical separations not designed for analytical purposes or for isotopic separations of an element. Analytical separations are included in the subcategory *Analytical Procedures* of this category, and separations of isotopes of an element are included in the category ISOTOPE TECHNOLOGY.

ENGINEERING

General

Information applicable to the main subject category but which is outside specific subcategories or is a combination of three or more subcategories.

Applications of Nuclear Explosions

Engineering applications of nuclear explosions or simulated nuclear explosions.

Facilities and Equipment

Plants, plant facilities, and equipment not designed for specific application in one of the other categories.

Heat Transfer and Fluid Flow

Theoretical studies and engineering applications of heat transfer and fluid flow. For thermodynamics and magnetofluiddynamics, see the subcategory *General* of the category PHYSICS.

Materials Testing

Information primarily concerned with equipment, methods, and techniques for destructive or nondestructive testing. When the material is of primary interest, information on testing (including corrosion and erosion) is included in the category METALS, CERAMICS, AND OTHER MATERIALS.

Protective Structures

Design, construction, and effectiveness of blast and fallout shelters and other protective structures.

Vacuum Engineering

Design and construction of vacuum systems and equipment (e.g., vacuum pumps). Excludes properties of materials under vacuum environment and vacuum systems and equipment that are more appropriately categorized according to the application (e.g., a vacuum system specifically intended for an accelerator is included in the subcategory *Accelerators* of the category PHYSICS).

GEOLOGY AND MINERALOGY

General

Information applicable to the main subject category but which is outside specific subcategories or is a combination of two or more subcategories.

Natural Radioactivity and Fallout

Ground levels and movement of radioactive materials, both natural and artificial, and elemental and isotopic compositions of minerals.

Site Survey and Selection

Reactor and plant site-selection studies.

Techniques and Equipment

Use of radiometric techniques and equipment in geology and mineralogy, and seismology associated with nuclear-explosion detection.

Thorium and Uranium Minerals

Structures and properties of thorium and uranium minerals.

HEALTH AND SAFETY

Critical limits for moving and storing fissionable, radioactive, and toxic materials; experience in applied health physics; the development of, and experience with, personnel-protection procedures; and general industrial- and radiation-hazards analyses. Excludes studies performed to establish maximum allowable concentrations and limits of exposure, which are included in the subcategory *Radiation Hazards and Protection* of the category BIOLOGY AND MEDICINE.

INSTRUMENTATION

This category excludes the specific applications of an instrument. These are categorized by the subject of the application.

General

Design, testing, and use of instruments, except radiation detection, where these aspects of instrumentation are the main subjects.

Radiation Detection

Radiation-detection instruments and their components.

Radiation Effects

Effects of radiation on any instrument or instrument component.

ISOTOPE TECHNOLOGY

General

Information applicable to the main subject category but which is outside specific subcategories or is a combination of two or more subcategories.

Industrial Applications

Applications to industrial processes and equipment for such applications. Applications to basic research are found under such categories as CHEMISTRY.

Power Application

Applications of radioisotopes in the production of electric or thermal energy or thrust.

Separation and Production

Separation of isotopes of one element in microquantities or macroquantities. Separation of isotopes of different elements is included in the subcategory *Separation Processes and Procedures* of the category CHEMISTRY.

MATHEMATICS AND COMPUTERS

Pure mathematics; statistics; and the design, development, and operation of computers. Information on applied mathematics and computer applications is categorized according to the application (e.g., computers used as simulators of various devices and pro-

cesses are categorized in the same manner as the device or process simulated; computer codes and applied mathematics are categorized on the basis of the application).

METALS, CERAMICS, AND OTHER MATERIALS

The term "other materials" refers to such substances as plastics, rubbers, other elastomers, wood, concrete, graphite, and petroleum.

General

Information applicable to the main subject category but which is outside specific subcategories or is a combination of two or more subcategories.

Corrosion

Corrosion and erosion studies that appear to be directed toward specific applications. Excludes studies primarily concerned with physical chemistry, reaction kinetics, etc., which are included in the category CHEMISTRY.

Fabrication

Fabrication methods, procedures, and equipment, including those for fuel elements and reactor components.

Properties and Structure

Mechanical, physical, and structural properties.

Radiation Effects

Effects of radiation on mechanical, physical, and structural properties. Chemical effects of radiation are included in the subcategory *Radiation Chemistry* of the category CHEMISTRY.

METEOROLOGY

Atmospheric and weather conditions, climatology, general meteorological problems, and meteorological studies made for the purpose of obtaining information on the movement of air-borne particulate matter. Meteorology included in site-selection reports is included in the subcategory *Site Survey and Selection* of the category GEOLOGY AND MINERALOGY.

PHYSICS

General

Information which falls under the main subject category but which is outside specific subcategories or is a combination of two or more subcategories.

Accelerators

Theory, design, development, construction, and operation of high-voltage machines and particle accelerators.

Astrophysics and Cosmology

Origin and cosmic abundance of elements, isotopic composition of meteorites, stellar processes, and stellar magnetic fields.

Atomic Physics

Physical properties and theory of atoms and their interactions, reactions, and scattering. Also includes the production of atomic beams and the effects and mechanisms of atomic beam bombardment of materials.

Cosmic Radiation

Origin, intensity variations, acceleration processes, etc., of cosmic radiation. For the properties of specific cosmic particles or the use of cosmic radiation merely as a source of high-energy particles, see the subcategories *Elementary Particles and Radiations* and *Nuclear Properties and Reactions* of this category, depending on the emphasis.

Criticality Studies

Basic studies of nuclear criticality. Critical limits of movement and storage of radioactive materials are included in the category HEALTH AND SAFETY. Criticality studies pertaining to reactors are included in the category REACTOR TECHNOLOGY.

Direct Energy Conversion

Equipment, techniques, and theory of direct-energy conversion, including magnetohydrodynamic cells and thermionic cells.

Elementary Particles and Radiations

Properties and theory, including interactions with each other. The diffusion of particles and radiations in shielding materials and configurations is included in the subcategory *Shielding* of this category.

Field Theory and Quantum Mechanics

Basic studies of the behavior and interactions of fields, the kinetics of field-matter systems, and the quantization of energy and energy transfer. Specific applications of field theory and quantum mechanics are found in other subcategories.

Geophysics

Geomagnetic fields, upper atmosphere physics, and physics of the crust and interior of the earth; this excludes cosmic radiation.

Low Temperature Physics

Cryogenics, superconductivity, and superfluidity research. Applications are found under categories for the applications.

Neutron Physics

Experimental and mathematical treatments of neutron absorption, attenuation, moderation, multiplication, scattering, etc., in real and hypothetical media. Such studies conducted for a specified application are categorized according to the application (e.g., the category REACTOR TECHNOLOGY and the subcategories *Criticality Studies* and *Shielding* of this category). Neutron reactions with specific nuclei are included in the subcategory *Nuclear Properties and Reactions* of this category.

Nuclear Properties and Reactions

Experimental and theoretical studies relating to properties, reactions, and interactions of nuclei.

Plasma Physics and Thermonuclear Processes

Phenomena of electric discharges; fundamental plasma experiments and theory; theory, design, development, and experimentation relating to controlled release of energy from thermonuclear reactions; and research and theory on electrodynamics and magnetodynamics applicable to plasma studies and thermonuclear processes.

Shielding

Theoretical and experimental studies relating to the diffusion, attenuation, absorption, and scattering of particles and radiations in shielding materials and configurations. For information on the fabrication of shielding materials and configurations, see the subcategory *Fabrication* of the category METALS, CERAMICS, AND OTHER MATERIALS.

REACTOR TECHNOLOGY

General

Information applicable to the main subject category but which is outside specific subcategories or is a combination of two or more subcategories.

Auxiliaries and Components

Design and construction of auxiliaries, components, control systems, and instrumentation not intended for a specific reactor.

Criticality Studies

Theoretical and experimental studies of neutron physics and parameters of unspecified reactors.

Design and Feasibility

Design and feasibility studies of reactor types not designated as power, process heat, production, propulsion, research, or test and not associated with a specific reactor.

Fuels

Design and theory of fuel elements not associated with a specific reactor. Studies of fuel-element materials are included in the category METALS, CERAMICS, AND OTHER MATERIALS.

Power and Power-Breeder Reactors

Design, construction, feasibility, operation, and economics of specific reactors and classes of reactors. Also includes auxiliaries, components, and criticality studies for such reactors.

Process Heat Reactors

Reactors designed to produce heat for uses other than the production of electricity or propulsion. Reactors designed to produce electricity and process heat are included in the subcategory *Power and Power-breeder Reactors* of this category.

Production Reactors

Design, construction, feasibility, economics, and operation of reactors devoted primarily to the production of fissionable materials or isotopes. Also includes auxiliaries, components, and criticality studies for such reactors.

Propulsion and Space

Design, construction, feasibility, economics, and operation of reactors for the propulsion of vehicles (land, water, air, and space). Also includes auxiliaries, components, and criticality studies for such reactors. The vehicles themselves are included only if the influence on the reactor is considered.

Research and Test Reactors

Design, construction, feasibility, economics, and operation of reactors used for radiation-effects studies and other basic research. Also includes auxiliaries, components, and criticality studies for such reactors.

WASTE DISPOSAL AND PROCESSING

Chemistry and chemical engineering for the storage, disposal, and control of radioactive waste materials, including the treatment of waste materials prior to disposal, such as concentration, neutralization, filtration, or calcination. Safety aspects of radioactive waste handling and disposal are included in the category HEALTH AND SAFETY. Ecological aspects of waste materials are included in the subcategory *Ecology* of the category BIOLOGY AND MEDICINE. Some radiochemical aspects are included in the subcategory *Radiochemistry* of the category CHEMISTRY. Fuel-

element processing is included in the subcategory *Separation Processes and Procedures* of the category CHEMISTRY.

GENERAL AND MISCELLANEOUS

This category, for the most part, contains abstracts of research and development reports of the U. S. Atomic Energy Commission and its contractors that are essentially nonnuclear in nature or are outside the scope of the other categories in *NSA*. Such abstracts have been included in *Research and Development Abstracts of the USAEC*. *RDA* was discontinued after issue number 8, Dec. 1963.

Additionally, both AEC and non-AEC originated broad summary type documents with diverse subject matter will be found under this category.

Appendix II

SUBJECT SCOPE OF NUCLEAR SCIENCE ABSTRACTS

Nuclear science is the study of the production, properties, principles, and phenomena of atomic nuclei, sub-atomic particles, and gamma and x radiation. Nuclear technology is the application of the principles and phenomena of nuclear science to the fields of science and engineering, and, conversely, the application of other science and engineering to the problems of nuclear science. These definitions, however, require further refinement to permit the user to determine exactly what *NSA* covers and also to permit uncontested selection or rejection of any piece of literature for *NSA*. Material selected for *NSA* is based solely on its subject content regardless of its form, origin, or language. The subject matter for *NSA* lies in 16 major subject fields, the limits of which are stated in the following scope notes. The specific interest in each of the elements is given in the second part of these notes.

Subject Fields of Interest

BIOLOGY AND MEDICINE

Ecological studies of radioactive materials

Metabolism, tissue distribution, and toxicology of all radioisotopes, of the actinides (including actinium), and of the fission-product elements strontium, iodine, barium, and cesium

Radiation-effects studies (particle, x ray, gamma ray, and ultraviolet) in all fields of biology, including second- and third-generation effects

Radiation hazards and protection

Radiation sickness

Radiotherapy and radiodiagnosis only if new equipment or techniques are used or if radiation side effects are discussed

Tracer studies if the isotope itself is the object of study or if the information on the tracer technique is new

CHEMISTRY

All chemistry of actual or simulated fission products and of actinides (including actinium)

Analysis, determination, and separation of lanthanides (including lanthanum)

Chemical methods for separating isotopes

Chemical stability of reactor moderators, fuels, coolants, control elements, and structures in storage or under accidental conditions, such as fire, flooding, or transport accidents

Chemistry involved in the preparation and use of radiation targets

Chemistry of compounds of noble or inert gases, including preparation or attempted preparation

Chemistry of radioactive waste processing, storage, and disposal

Chemistry of reactor coolants, moderators, and fuels
Corrosion and erosion in reactor fuel processing and waste disposal
Corrosion and erosion under actual or simulated reactor conditions
Isotope effects on chemical properties and reactions
Isotopic labeling of chemical compounds
Laboratory techniques for studying and processing thorium and uranium minerals
Radiation chemistry, radiochemistry, and radioanalytical techniques and equipment
Radioactive decontamination
Separation chemistry of reactor fuels and breeding blankets

ENGINEERING

Control engineering and automated systems applied to nuclear facilities, plants, or laboratories
Design and construction of laboratories, pilot plants, plant facilities, and equipment for handling and processing radioactive materials, reactor fuel and blanket materials, or feed materials (beginning with UO_3)
Design and construction of structures for protection against the effects of nuclear explosions
Engineering applications of, and seismological studies associated with, nuclear or simulated nuclear explosions
Heat-transfer and fluid-flow studies applied to nuclear facilities, plants, or laboratories
Magnetofluiddynamic flow
Materials testing limited to applications in nuclear technology or to new techniques involving nuclear phenomena
Ultrahigh vacuum engineering, i.e., 10^{-9} torr or greater, and other vacuum engineering as applied to accelerators or to thermonuclear devices

GEOLOGY AND MINERALOGY

Engineering applications of nuclear or simulated nuclear explosions
Geology studies for the selection of reactor, weapons-test, and waste-disposal sites
Hydrological studies involving movement of radioactive waste and fallout
Identification and description of new thorium and uranium minerals
Laboratory techniques for studying and processing thorium and uranium minerals
New radiometric techniques and equipment, including those used for geological-age determination and well logging
Seismology associated with nuclear or simulated nuclear explosions or with site selection
Studies of natural radioactivity

HEALTH AND SAFETY

All factors concerned with radiation incidents or with accidents involving radioactive or fissionable materials, including decontamination
Maximum permissible concentrations of radioactive materials
Protective measures and equipment, safety procedures, and criticality and hazards studies associated with reactors or radiations
Radiation-dosage determinations, limits, and standards
Safety regulations and limits for handling, processing, storing, and transporting fissionable and radioactive materials

INSTRUMENTATION

Design, development, construction, testing, theory, and evaluation of radiation-detection instruments and systems
Instrumentation, in addition to that for radiation detection, only if directly applied in nuclear technology
Radiation effects on instruments and components

ISOTOPE TECHNOLOGY

Isotope effects on the physical and chemical properties of matter
Methods for labeling compounds
Preparing, handling, and storing radiation sources and radioisotopes
Production and separation of isotopes (stable and radioactive)
Tracer studies only if the isotope itself is the object of study or if the information on the tracer technique is new
Use of isotopes or fission products as radiation sources or power sources except in routine applications (e.g., routine laboratory, industrial, and medical uses)

MATHEMATICS AND COMPUTERS

Applications of computers, codes, and mathematics to the solution of nuclear-science problems

METALLURGY AND CERAMICS

Corrosion and erosion in reactor fuel processing and waste disposal
Corrosion and erosion under actual or simulated reactor conditions
Metallurgical studies on elements and their alloys and systems for reactor, accelerator, or other nuclear applications
Metallurgy of the actinides, the lanthanides, and the elements beryllium, molybdenum, niobium, rhenium, tantalum, technetium, tungsten, yttrium, and zirconium, including the metallurgy of their alloys, compounds, and systems
Radiation effects on materials
Studies on ceramics, refractories, and cermets for reactor, accelerator, or other nuclear applications

METEOROLOGY

Meteorological studies for the selection of reactor and explosion test sites
Radioactive aerosol and gas production, dispersal, precipitation, agglomeration, and stack disposal
Radioactive fallout
Radioactivity in the atmosphere

NUCLEAR EXPLOSIONS

All scientific and technical aspects of actual or simulated nuclear explosions

PHYSICS

Accelerators (not including propulsion devices)
  All scientific and technical aspects, including the ion source
Astrophysics
  Cosmic origin and abundance of elements and isotopes
  Gravitational collapse
  Other solar and stellar phenomena only when nuclear reactions, particle kinetics, plasma, or magnetofluiddynamics are involved
Cosmic Radiation
  All scientific and technical aspects
Cryogenics
  As applied to nuclear science
  Involving nuclear phenomena or techniques
Direct Energy Conversion
  Any study involving nuclear phenomena or techniques
  Other studies limited to magnetofluiddynamic, plasma, and thermionic devices and applications of thermoelectric devices to reactor or other nuclear facilities
Field Theory and Quantum Electrodynamics
Geophysics
  Auroral or ionospheric phenomena only when particle kinetics are discussed
  High-altitude nuclear detonations and effects
  Particle kinetics and geomagnetic trapping in radiation belts
  Particle phenomena resulting from solar-storm interactions with the earth's magnetic field
  Seismic studies for the detection of nuclear explosions
Nuclear Physics
  Absorption, interaction, and scattering of gamma and x radiation
  Acceleration and nuclear reactions of ions, e.g., C^{14} ions
  All properties, reactions, and phenomena associated with the nucleus, either experimental or theoretical
  All scientific and technical aspects of elementary particles
  Electron-paramagnetic-resonance and nuclear-magnetic-resonance studies when the technique is the object of study
  Mössbauer-effect studies when the technique is the object of study
Plasma Physics
  Effects of electric or magnetic fields on plasma oscillations and particle dynamics
  Electromagnetic radiation emitted by ionized gases, e.g., cyclotron radiation
  Magnetofluiddynamics
  Motions and reactions of particles in electric and magnetic fields, excluding electron-tube and arc phenomena
  Production, properties, containment, and heating of plasma, excluding electron-tube plasma and routine applications of arc plasma
  Shock-produced plasma, excluding atmospheric re-entry and exploding-wire phenomena
  Theory, design, development, and experimen-

tation (including ionization studies) relating to controlled fusion
Shielding
All aspects of shielding against ionizing radiation, neutrons, and accelerated particles
Thermal shielding for reactors and for protection against nuclear explosions
Solid-State Physics
Limited to radiation effects, radiation detectors, and nuclear and reactor applications
Superconductivity
All scientific and technical aspects
Vacuum Technology
Ultrahigh vacuum (10^{-9} torr or greater)
Vacuum-technology applications to accelerators or to thermonuclear devices

RADIATION EFFECTS

All effects of particles (including ions) or of x or gamma radiation
Only biological effects of ultraviolet radiation
Thermal-radiation effects only if associated with nuclear explosions

RADIATION-RESISTANT MATERIALS

All scientific and technical aspects

REACTOR TECHNOLOGY

All scientific, technical, and economic aspects of nuclear fission and fusion reactors, including feasibility studies and site selection
Design, development, and testing of nuclear power plants and of components modified because of the reactor
Reactor theory, including neutron physics, criticality studies, reactor criticality effects of any element, and reactor control

WASTE DISPOSAL AND PROCESSING

All scientific and technical information dealing with radioactive waste

Extent of Interest in the Elements

ACTINIUM
All scientific and technical aspects

ALUMINUM
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

AMERICIUM
All scientific and technical aspects

ANTIMONY
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

ARGON
Applications of the element in nuclear technology or the behavior of the element in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

ARSENIC
Applications of the element or its compounds or systems in nuclear technology or the behavior of the element, its compounds, or its systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes

Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

ASTATINE
All scientific and technical aspects

BARIUM
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

BERKELIUM
All scientific and technical aspects

BERYLLIUM
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Metallurgy of the element or its alloys, compounds, or systems, excluding mineralogy
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

BISMUTH
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

BORON
Applications of the element or its compounds or systems in nuclear technology or the behavior of the element, its compounds, or its systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

BROMINE
Applications of the element or its compounds or systems in nuclear technology or the behavior of the element, its compounds, or its systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

CADMIUM
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

CALCIUM
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

CALIFORNIUM
All scientific and technical aspects

CARBON
Applications of the element or its compounds or systems in nuclear technology or the

behavior of the element, its compounds, or its systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Properties and fabrication of nuclear-grade graphite and graphite fuel materials
Radiation effects
Radiochemistry

CERIUM
Analysis, determination, and separation
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Metallurgy of the element or its alloys, compounds, or systems, excluding mineralogy
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

CESIUM
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

CHLORINE
Applications of the element or its compounds or systems in nuclear technology or the behavior of the element, its compounds, or its systems in an actual or a simulated reactor environment
Isotopes (excluding routine application as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

CHROMIUM
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

COBALT
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

COPPER
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

CURIUM
All scientific and technical aspects

DYSPROSIUM
Analysis, determination, and separation
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes

Metallurgy of the element or its alloys, compounds, or systems, excluding mineralogy
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

EINSTEINIUM
All scientific and technical aspects

ERBIUM
Analysis, determination, and separation
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Metallurgy of the element or its alloys, compounds, or systems, excluding mineralogy
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

EUROPIUM
Analysis, determination, and separation
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Metallurgy of the element or its alloys, compounds, or systems, excluding mineralogy
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

FERMIUM
All scientific and technical aspects

FLUORINE
Applications of the element or its compounds or systems in nuclear technology or the behavior of the element, its compounds, or its systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

FRANCIUM
All scientific and technical aspects

GADOLINIUM
Analysis, determination, and separation
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Metallurgy of the element or its alloys, compounds, or systems, excluding mineralogy
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

GALLIUM
Applications of the element and its alloys, compounds, and systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

GERMANIUM
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

GOLD
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment

Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

HAFNIUM
Applications of the element and its alloys, compounds, and systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

HELIUM
Applications of the element in nuclear technology or the behavior of the element in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

HOLMIUM
Analysis, determination, and separation
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Metallurgy of the element or its alloys, compounds, or systems, excluding mineralogy
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

HYDROGEN
Applications of the element or its compounds and systems in nuclear technology or the behavior of the element, its compounds, or its systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of deuterium and tritium
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

INDIUM
Applications of the element and its alloys, compounds, and systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

IODINE
Applications of the element or its compounds or systems in nuclear technology or the behavior of the element, its compounds, or its systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

IRIDIUM
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

IRON
Applications of the element and its alloys or systems, including steel and stainless steel, in nuclear technology or the behavior of the element, its alloys, or its systems in an actual or a simulated reactor environment

Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

KRYPTON
Applications of the element in nuclear technology or the behavior of the element in an actual or a simulated reactor environment
Chemistry of any compounds (e.g., KrF_2 or KrF_4), including preparation or attempted preparation
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

LANTHANUM
Analysis, determination, and separation
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Metallurgy of the element or its alloys, compounds, or systems, excluding mineralogy
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

LAWRENCIUM (103)
All scientific and technical information

LEAD
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

LITHIUM
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

LUTETIUM
Analysis, determination, and separation
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Metallurgy of the element or its alloys, compounds, or systems, excluding mineralogy
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

MAGNESIUM
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

MANGANESE
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions

Radiation effects
Radiochemistry

MENDELEVIUM
All scientific and technical aspects

MERCURY
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

MOLYBDENUM
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Metallurgy of the element or its alloys, compounds, or systems, excluding mineralogy
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

NEODYMIUM
Analysis, determination, and separation
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Metallurgy of the element or its alloys, compounds, or systems, excluding mineralogy
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

NEON
Applications of the element in nuclear technology or the behavior of the element in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

NEPTUNIUM
All scientific and technical aspects

NICKEL
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

NIOBIUM
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Metallurgy of the element or its alloys, compounds, or systems, excluding mineralogy
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

NITROGEN
Applications of the element or its compounds or systems in nuclear technology or the behavior of the element, its compounds, or its systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

NOBELIUM
All scientific and technical aspects

OSMIUM
- Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
- Isotopes (excluding routine applications as tracers or radiation sources)
- Metabolism, tissue distribution, and toxicology of radioisotopes
- Nuclear properties and nuclear reactions
- Radiation effects
- Radiochemistry

OXYGEN
- Applications of the element or its compounds or systems in nuclear technology or the behavior of the element, its compounds, or its systems in an actual or a simulated reactor environment
- Isotopes (excluding routine applications as tracers or radiation sources)
- Metabolism, tissue distribution, and toxicology of radioisotopes
- Nuclear properties and nuclear reactions
- Radiation effects
- Radiochemistry

PALLADIUM
- Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
- Isotopes (excluding routine applications as tracers or radiation sources)
- Metabolism, tissue distribution, and toxicology of radioisotopes
- Nuclear properties and nuclear reactions
- Radiation effects
- Radiochemistry

PHOSPHORUS
- Applications of the element or its compounds or systems in nuclear technology or the behavior of the element, its compounds, or its systems in an actual or a simulated reactor environment
- Isotopes (excluding routine applications as tracers or radiation sources)
- Metabolism, tissue distribution, and toxicology of radioisotopes
- Nuclear properties and nuclear reactions
- Radiation effects
- Radiochemistry

PLATINUM
- Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
- Isotopes (excluding routine applications as tracers or radiation sources)
- Metabolism, tissue distribution, and toxicology of radioisotopes
- Nuclear properties and nuclear reactions
- Radiation effects
- Radiochemistry

PLUTONIUM
- All scientific and technical aspects

POLONIUM
- All scientific and technical aspects

POTASSIUM
- Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
- Isotopes (excluding routine applications as tracers or radiation sources)
- Metabolism, tissue distribution, and toxicology of radioisotopes
- Nuclear properties and nuclear reactions
- Radiation effects
- Radiochemistry

PRASEODYMIUM
- Analysis, determination, and separation
- Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
- Isotopes (excluding routine applications as tracers or radiation sources)
- Metabolism, tissue distribution, and toxicology of radioisotopes
- Metallurgy of the element or its alloys, compounds, or systems, excluding mineralogy
- Nuclear properties and nuclear reactions
- Radiation effects
- Radiochemistry

PROMETHIUM
- Analysis, determination, and separation
- Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment

Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Metallurgy of the element or its alloys, compounds, or systems, excluding mineralogy
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

PROTACTINIUM
All scientific and technical aspects

RADIUM
All scientific and technical aspects

RADON
All scientific and technical aspects

RHENIUM
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Metallurgy of the element or its alloys, compounds, or systems, excluding mineralogy
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

RHODIUM
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

RUBIDIUM
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

RUTHENIUM
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

SAMARIUM
Analysis, determination, and separation
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Metallurgy of the element or its alloys, compounds, or systems, excluding mineralogy
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

SCANDIUM
Analysis, determination, and separation
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Metallurgy of the element or its alloys, compounds, or systems, excluding mineralogy
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

SELENIUM
Applications of the element or its compounds or systems in nuclear technology or the

behavior of the element, its compounds, or its systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

SILICON
Applications of the element or its compounds or systems in nuclear technology or the behavior of the element, its compounds, or its systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

SILVER
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

SODIUM
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

STRONTIUM
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

SULFUR
Applications of the element or its compounds or systems in nuclear technology or the behavior of the element, its compounds, or its systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

TANTALUM
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Metallurgy of the element or its alloys, compounds, or systems, excluding mineralogy
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

TECHNETIUM
All scientific and technical aspects

TELLURIUM
Applications of the element or its compounds or systems in nuclear technology or the behavior of the element, its compounds, or its systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

TERBIUM
Analysis, determination, and separation

Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Metallurgy of the element or its alloys, compounds, or systems, excluding mineralogy
Radiation effects
Radiochemistry

THALLIUM
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

THORIUM
All scientific and technical aspects except exploration, mining, ore processing, and routine industrial uses, e.g., thoriated cathodes

THULIUM
Analysis, determination, and separation
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Metallurgy of the element or its alloys, compounds, or systems, excluding mineralogy
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

TIN
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

TITANIUM
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

TUNGSTEN
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Metallurgy of the element or its alloys, compounds, or systems, excluding mineralogy
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

URANIUM
All scientific and technical aspects except exploration, mining, ore processing, and routine industrial applications

VANADIUM
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

XENON
- Applications of the element in nuclear technology or the behavior of the element in an actual or a simulated reactor environment
- Chemistry of any compounds (e.g., XeF_4, XeF_6, or XeO_3), including preparation or attempted preparation
- Isotopes (excluding routine applications as tracers or radiation sources)
- Metabolism, tissue distribution, and toxicology of radioisotopes
- Nuclear properties and nuclear reactions
- Radiation effects
- Radiochemistry

YTTERBIUM
- Analysis, determination, and separation
- Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
- Isotopes (excluding routine applications as tracers or radiation sources)
- Metabolism, tissue distribution, and toxicology of radioisotopes
- Metallurgy of the element or its alloys, compounds, or systems, excluding mineralogy
- Nuclear properties and nuclear reactions
- Radiation effects
- Radiochemistry

YTTRIUM
- Analysis, determination, and separation
- Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
- Isotopes (excluding routine applications as tracers or radiation sources)
- Metabolism, tissue distribution, and toxicology of radioisotopes
- Metallurgy of the element or its alloys, compounds, or systems, excluding mineralogy
- Nuclear properties and nuclear reactions
- Radiation effects
- Radiochemistry

ZINC
- Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
- Isotopes (excluding routine applications as tracers or radiation sources)
- Metabolism, tissue distribution, and toxicology of radioisotopes
- Nuclear properties and nuclear reactions
- Radiation effects
- Radiochemistry

ZIRCONIUM
- Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
- Isotopes (excluding routine applications as tracers or radiation sources)
- Metabolism, tissue distribution, and toxicology of radioisotopes
- Metallurgy of the element or its alloys, compounds, or systems, excluding mineralogy
- Nuclear properties and nuclear reactions
- Radiation effects
- Radiochemistry

Appendix III

JOURNAL LIST

This is a list of journals and their abbreviations arranged alphabetically by the abbreviation used in *NSA*. Titles marked by an asterisk (*) are those that are scanned regularly. Titles without asterisks are journals from which some abstracts were taken during Volume 18 although these journals are not scanned regularly.

The Russian journals identified by a dagger (†) are available commercially in complete English translation.

Cross references have been included for some non-English language titles as well as for variant forms of titles used in this list. For journals on the present scanning list that fall in either of these categories, the asterisk appears only with the form of the title used for *NSA*. Some journals which have undergone name changes in recent years have been so identified parenthetically after the title. The original language title for a translated journal is given in parentheses after the English title.

Abhandl. Deut. Akad. Wiss. Berlin, Kl. Med.
Abhandlungen der Deutschen Akademie der Wissenchaften zu Berlin, Klasse fuer Medizin *(Germany)*

ABM (Bol. Assoc. Brasil. Metais) (Sao Paulo)
ABM (Boletim da Associacao Brasileira de Metais) (Sao Paulo) *(Brazil)*

Abstr. Uppsala Dissertations Sci.
Abstracts of Uppsala Dissertations in Science (formerly carried under the title: Acta Universitatis Upsaliensis) *(Sweden)*

Acad. Rep. Polulare Romine, Baza Cercetari Stiint. Timisoara, Studii Cercetari Stiinte Tehnice
*Academia Republicii Polulare Romine, Baza de Cercetari Stiintifice Timisoara, Studii si Cercetari Stiinte Tehnice *(Romania)*

Acad. Rep. Populare Romine, Filiala Iasi, Studii Cercetari Stiint., Fiz. Stiinte Tehn.
*Academia Republicii Populare Romine, Filiala Iasi, Studii si Cercetari Stiintifice, Fizica si Stiinte Tehnice *(Romania)*

Acad. Rep. Populare Romine, Studii Cercetari Biochim.
Academia Republicii Populare Romine, Institutul de Biochemie, Studii si Cercetari de Biochimie *(Romania)*

Acad. Rep. Populare Romine, Studii Cercetari Chim.
Academia Republicii Populare Romine, Studii si Cercetari de Chimie *(Romania)*

Acad. Rep. Populare Romine, Studii Cercetari Fiz.
*Academia Republicii Populare Romine, Institutul de Fizica Atomica si Institutul de Fizica, Studii si Cercetari de Fizica *(Romania)*

Acad. Rep. Populare Romine, Studii Cercetari Inframicrobiol.
Academia Republicii Populare Romine, Institutul de Inframicrobiologie, Studii si Cercetari de Inframicrobiologie *(Romania)*

Accad. Ital. Vite Vino, Siena, Atti
Accademia Italiana della Vite e del Vino, Siena, Atti *(Italy)*

Accad. Pualiese Sci., Atti Relaz., Pt. 2
Accademia Pualiese delle Scienze, Atti e Relazioni, Parte 2 *(Italy)*

Acier-Stahl-Steel
Acier-Stahl-Steel *(Belgium)*

Acqua Ind.
Acqua Industriale *(Italy)*

Acta Anat.
*Acta Anatomica *(Switzerland)*

Acta Biochim. Biophys. Sinica
Acta Biochimica et Biophysica Sinica
see Sheng Wu Hua Hsueh Yu Shing Wu Wu Li Hsueh Pao

Acta Biochim. Polon. (English Transl.)
*Acta Biochimica Polonica (English Translation) *(Poland)*

Acta Biol. Acad. Sci. Hung.
Acta Biologica Academiae Scientiarum Hungaricae *(Hungary)*

Acta Biol. Exptl. Sinica
Acta Biologiae Experimentalis Sinica
see Shih Yen Sheng Wu Hsueh Pao

Acta Biol. Med. Ger.
Acta Biologica et Medica Germanica *(Germany)*

Acta Botan. Acad. Sci. Hung.
Acta Botanica Academiae Scientiarum Hungaricae *(Hungary)*

Acta Cardiol.
Acta Cardiologica *(Belgium)*

Acta Chem. Scand.
*Acta Chemica Scandinavica *(Denmark)*

Acta Chim. Acad. Sci. Hung.
*Acta Chimica Academiae Scientiarum Hungaricae *(Hungary)*

Acta Chim. Sinica
Acta Chemica Sinica
see Hua Hsueh Hsueh Pao

Acta Chir. Acad. Sci. Hung.
Acta Chirurgica Academiae Scientiarum Hungaricae *(Hungary)*

Acta Chir. Belg.
Acta Chirurgica Belgica *(Belgium)*

Acta Chir. Orthopaed. Traumatol. Cech.
Acta Chirurgiae Orthopaedicae et Traumatologiae Cechoslovaca *(Czechoslovakia)*

Acta Chir. Scand.
Acta Chirurgica Scandinavica *(Sweden)*

Acta Cient. Venezolana
*Acta Cientifica Venezolana *(Venezuela)*

Acta Clin. Belg.
Acta Clinica Belgica *(Belgium)*

Acta Cryst.
*Acta Crystallographica *(Denmark)*

Acta Cytol.
*Acta Cytologica *(U. S.)*

Acta Electron.
*Acta Electronica *(France)*

Acta Fac. Pharm. Bohemoslov.
Acta Facultatis Pharmaceuticae Bohemoslovenicae *(Czechoslovakia)*

Acta Genet. Statist. Med.
Acta Genetica et Statistica Medica *(Switzerland)*

Acta Geophys. Polon.
*Acta Geophysica Polonica *(Poland)*

Acta Geophys. Sinica
Acta Geophysica Sinica
see Ti Ch'iu Wu Li Hsueh Pao

Acta Gerontol.
*Acta Gerontologica *(Italy)*

Acta Gynaecol. Obstet. Hispano Lusitana
*Acta Gynaecologica et Obstetrica Hispano Lusitana *(Portugal)*

Acta Haematol.
Acta Haematologica *(Switzerland)*

Acta Haematol. Japon.
Acta Haematologica Japonica
see Nippon Ketsueki Gakkai Zasshi

Acta Histochem.
*Acta Histochemica *(Germany)*

Acta Iberica Radiol.-Cancerol.
Acta Iberica Radiologica-Cancerologica *(Spain)*
Acta IMEKO (Intern. Messtech. Konf.), 1961
Acta IMEKO (Internationale Messtechnische Konferenz), 1961 *(Hungary)*
Acta Isotopica
*Acta Isotopica *(Italy)*
Acta Med. Acad. Sci. Hung.
Acta Medica Academiae Scientiarum Hungaricae *(Hungary)*
Acta Med. Biol. (Niigata)
Acta Medica et Biologica (Niigata) *(Japan)*
(Japan)
Acta Med. Hidalguenese
*Acta Medica Hidalguense *(Mexico)*
Acta Med. Iranica
*Acta Medica Iranica *(Iran)*
Acta Med. Iugoslav.
Acta Medica Iugoslavica *(Yugoslavia)*
Acta Med. Okayama
*Acta Medicinae Okayama *(Japan)*
Acta Med. Polona
*Acta Medica Polona *(Poland)*
Acta Med. Scand.
Acta Medica Scandinavica *(Sweden)*
Acta Med. Tenerife
Acta Medica de Tenerife *(Canary Islands)*
Acta Med. Vet.
Acta Medica Veterinaria *(Italy)*
Acta Met.
*Acta Metallurgica *(U. S.)*
Acta Microbiol. Acad. Sci. Hung.
Acta Microbiologica Academiae Scientiarum Hungaricae *(Hungary)*
Acta Microbiol. Polon.
*Acta Microbiologica Polonica *(Poland)*
Acta Morphol. Acad. Sci. Hung., Suppl.
Acta Morphologica Academiae Scientiarum Hungaricae, Supplementum *(Hungary)*
Acta Neurochir.
Acta Neurochirurgica *(Austria)*
Acta Neurol. Latinoam.
*Acta Neurologia Latinoamericana *(Uruguay)*
Acta Neuropathol.
Acta Neuropathologica *(Germany)*
Acta Neuropsiquiat. Arg.
*Acta Neuropsiquiatrica Argentina *(Argentina)*
Acta Obstet. Gynecol. Scand.
Acta Obstetricia et Gynecologica Scandinavica *(Sweden)*
Acta Odontol. Scand.
Acta Odontologica Scandinavica *(Sweden)*
Acta Oncol.
*Acta Oncologica *(Spain)*
Acta Orthopaed. Scand.
Acta Orthopaedica Scandinavica *(Denmark)*
Acta Oto-Laryngol., Suppl.
Acta Oto-Laryngologica, Supplementum *(Sweden)*
Acta Paediat.
*Acta Paediatrica *(Sweden)*
Acta Pathol. Japon.
*Acta Pathologica Japonica *(Japan)*
Acta Pathol. Microbiol. Scand.
Acta Pathologica et Microbiologica Scandinavica *(Denmark)*
Acta Pharmacol. Toxicol.
Acta Pharmacologica et Toxicologica *(Denmark)*
Acta Pharm. Sinica
Acta Pharmaceutica Sinica
see Yao Hsueh Hsueh Pao
Acta Phys. Acad. Sci. Hung.
*Acta Physica Academiae Scientiarum Hungaricae *(Hungary)*
Acta Phys. Austriaca
*Acta Physica Austriaca *(Austria)*
Acta Physiol. Acad. Sci. Hung.
Acta Physiologica Academiae Scientiarum Hungaricae *(Hungary)*
Acta Physiol. Latinoam.
Acta Physiologica Latinoamericana *(Argentina)*
Acta Physiol. Pharmacol. Neerl.
*Acta Physiologica et Pharmacologica Neerlandica *(Netherlands)*
Acta Physiol. Polon.
*Acta Physiologica Polonica *(Poland)*
Acta Physiol. Scand.
Acta Physiologica Scandinavica *(Sweden)*
Acta Physiol. Sinica
Acta Physiologica Sinica
see Sheng Li Hsueh Pao
Acta Phys. Polon.
*Acta Physica Polonica *(Poland)*
Acta Phys. Sinica
Acta Physica Sinica
see Wu Li Hsueh Pao
Acta Polytech. Scand., Phys. Nucl. Ser.
Acta Polytechnica Scandinavica, Physics including Nucleonics Series *(Sweden)*
Acta Radiol. Diagnosis
*Acta Radiologica, Diagnosis *(Sweden)*
Acta Radiol., Suppl.
*Acta Radiologica, Supplementum *(Sweden)*
Acta Radiol. Therapy, Phys., Biol.
*Acta Radiologica, Therapy, Physics, Biology *(Sweden)*
Acta Rheumatol. Scand.
*Acta Rheumatologica Scandinavica *(Sweden)*
Acta Schol. Med., Univ. Kioto
Acta Scholae Medicinalis, Universitatis in Kioto *(Japan)*
Actas Dermo-Sifilog.
*Actas Dermo-Sifiliograficas *(Spain)*
Acta Soc. Med. Upsalien.
*Acta Societatis Medicorum Upsaliensis *(Sweden)*
Acta Soc. Ophthalmol. Japon.
Acta Societatis Ophthalmologicae Japonicae
see Nippon Ganka Gakkai Zasshi
Acta Unio Intern. Contra Cancrum
*Acta Unio Internationalis Contra Cancrum *(Belgium)*
Acta Univ. Carolinae, Med.
Acta Universitatis Carolinae, Medica *(Czechoslovakia)*
Acta Univ. Debrecen. Ludovico Kossuth Nom.
Acta Universitatis Debreceniensis de Ludovico Kossuth Nominatae *(Hungary)*
Acta Univ. Szeged., Acta Phys. Chem.
Acta Universitatis Szegediensis, Acta Physica et Chemica *(Hungary)*
Acta Vet. Acad. Sci. Hung.
Acta Veterinaria Academiae Scientiarum Hungaricae *(Hungary)*
Acta Virol. (Prague)
*Acta Virologica (Praque) *(Czechoslovakia)*
Activatas Nervosa Super.
Activatis Nervosa Superior *(Czechoslovakia)*
Actualites Cardiol. Angeiol. Intern.
Actualites Cardiologiques et Angeiologiques Internationales *(France)*
Advan. Astronaut. Sci.
Advances in the Astronautical Sciences *(U. S.)*
Advan. Biol. Med. Phys.
Advances in Biological and Medical Physics *(U. S.)*
Advan. Catalysis
Advances in Catalysis and Related Subjects *(England)*
Advan. Chem. Phys.
Advances in Chemical Physics *(U. S.)*
Advan. Cryog. Eng.
Advances in Cryogenic Engineering *(U. S.)*
Advan. Energy Conversion
*Advanced Energy Conversion *(England)*
Advan. Inorg. Chem. Radiochem.
Advances in Inorganic Chemistry and Radiochemistry *(England)*
Advan. Phys.
*Advances in Physics *(England)*
Advan. X-Ray Anal.
Advances in X-Ray Analysis *(U. S.)*
A E G Mitt.
*A E G Mitteilungen *(Germany)*
AEI (Assoc. Elec. Ind.) Eng.
*AEI (Associated Electrical Industries) Engineering *(England)*
Aerospace Med.
Aerospace Medicine (formerly The Journal of Aviation Medicine) *(U. S.)*
Aerztl. Forsch.
Aerztliche Forschung *(Germany)*
Afrique Franc. Chir.
*Afrique Francaise Chirurgicale *(Algeria)*
Aggiorn. Mal. Infezione
*Aggiornamenti sulle Malattie da Infezione *(Italy)*

Agr. Biol. Chem. (Tokyo)
*Agricultural and Biological Chemistry (Tokyo) *(Japan)*
Aerossologie
Agressologie *(France)*
Agr. Ital. (Pisa)
Agricoltura Italiana, L' (Pisa) *(Italy)*
Agrobiologiya
Agrobiologiya *(U.S.S.R.)*
Agrochimica
Agrochimica *(Italy)*
Agron. J.
Agronomy Journal *(U. S.)*
Agron. Lusitana
*Agronomia Lusitana *(Portugal)*
AIAA (Am. Inst. Aeron. Astronaut.) J.
*AIAA (American Institute of Aeronautics and Astronautics) Journal (combining the ARS Journal and the Journal of Aerospace Sciences) *(U. S.)*
A.I.Ch.E. (Am. Inst. Chem. Engrs.) J.
*A.I.Ch.E. (American Institute of Chemical Engineers) Journal *(U. S.)*
Air Conditioning, Heating, Ventilating
Air Conditioning, Heating and Ventilating *(U. S.)*
Air Conditioning, Sanit. Eng. (Japan)
Air Conditioning, Sanitary Engineering (Japan)
see Kuki Chowa, Eisei Kogaku
Air Water Pollution
Air and Water Pollution *(U. S.-England)*
Akad. Nauk Ukr. RSR, Inst. Teploenerg., Zb. Prats
*Akademiya Nauk Ukrain'skoi RSR, Institut Teploenergetiki, Zbirnik Prats *(Ukrainian S.S.R.)*
Alexandria Med. J.
*Alexandria Medical Journal, The *(Egypt)*
Algerie Med.
*Algerie Medicale *(Algeria)*
Allergie Asthma
Allergie und Asthma *(Germany)*
Alloy Dig. Cb-6
Alloy Digest Cb-6 *(U. S.)*
Alluminio
Alluminio *(Italy)*
Aluminium
Aluminium *(Germany)*
Am. Ceram. Soc. Bull.
*American Ceramic Society Bulletin, The *(U. S.)*
Am. Chem. Soc., Div. Polymer Chem., Preprints
American Chemical Society, Division of Polymer Chemistry, Preprints *(U. S.)*
Am. City
American City, The *(U. S.)*
Am. Dyestuff Rptr.
American Dyestuff Reporter *(U. S.)*
Am. Ind. Hyg. Assoc. J.
*American Industrial Hygiene Association Journal *(U. S.)*
Am. Inst. Mining, Met. Petrol. Engrs., Inst. Metals Div., Spec. Rept. Ser.
American Institute of Mining, Metallurgical and Petroleum Engineers, Institute of Metals Division, Special Report Series *(U. S.)*
Am. J. Anat.
American Journal of Anatomy, The *(U. S.)*
Am. J. Botany
*American Journal of Botany *(U. S.)*
Am. J. Clin. Nutr.
American Journal of Clinical Nutrition, The *(U. S.)*
Am. J. Clin. Pathol.
*American Journal of Clinical Pathology *(U. S.)*
Am. J. Digest. Diseases
American Journal of Digestive Diseases, The *(U. S.)*
Am. J. Human Genet.
*American Journal of Human Genetics, The *(U. S.)*
Am. J. Med.
American Journal of Medicine, The *(U. S.)*
Am. J. Med. Electron.
American Journal of Medical Electronics *(U. S.)*
Am. J. Med. Sci.
American Journal of the Medical Sciences, The *(U. S.)*
Am. J. Nursing
American Journal of Nursing, The *(U. S.)*
Am. J. Obstet. Gynecol.
American Journal of Obstetrics and Gynecology *(U. S.)*
Am. J. Pathol.
*American Journal of Pathology, The *(U. S.)*
Am. J. Phys.
*American Journal of Physics *(U. S.)*
Am. J. Physiol.
*American Journal of Physiology, The *(U. S.)*
Am. J. Psychiat.
American Journal of Psychiatry *(U. S.)*
Am. J. Public Health
American Journal of Public Health and The Nation's Health *(U. S.)*
Am. J. Roentgenol., Radium Therapy Nucl. Med.
*American Journal of Roentgenology, Radium Therapy and Nuclear Medicine, The *(U. S.)*
Am. J. Surg.
American Journal of Surgery, The *(U. S.)*
Am. J. Vet. Res.
American Journal of Veterinary Research *(U. S.)*
Am. Math. Monthly
American Mathematical Monthly, The *(U. S.)*
Am. Midland Naturalist
American Midland Naturalist, The *(U. S.)*
Am. Mineralogist
*American Mineralogist, The *(U. S.)*
Am. Naturalist
*American Naturalist *(U. S.)*
Am. Rev. Respirat. Diseases
American Review of Respiratory Diseases *(U. S.)*
Am. Soc. Metals, Trans. Quart.
*American Society for Metals, Transactions Quarterly *(U. S.)*
Am. Soc. Testing Mater., Spec. Tech. Publ.
American Society for Testing and Materials, Special Technical Publication *(U. S.)*
Anais Acad. Brasil. Cienc.
*Anais da Academia Brasileira de Ciencias *(Brazil)*
Anais Brasil. Dermatol. Sifilog.
*Anais Brasileiros de Dermatologia e Sifilografia *(Brazil)*
Anais Brasil. Ginecol. (Rio de Janeiro)
*Anais Brasileiros de Ginecologia (Rio de Janeiro) *(Brazil)*
Anais Inst. Med. Trop. (Lisbon)
*Anais Instituto de Medicina Tropical (Lisbon) *(Portugal)*
Anal. Biochem.
*Analytical Biochemistry *(U. S.)*
Anal. Chem.
*Analytical Chemistry *(U. S.)*
Anal. Chim. Acta
*Analytica Chimica Acta *(Netherlands)*
Analele Stiint. Univ. "A. I. Cuza," Iasi, Sect. I
Analele Stiintifice ale Universitatii "A. I. Cuza," din Iasi, Sectiunea I *(Romania)*
Anales Hosp. Militar Central (Lima, Peru)
*Anales del Hospital Militar Central (Lima, Peru) *(Peru)*
Anales Inst. Corachan (Barcelona)
*Anales del Instituto Corachan (Barcelona) *(Spain)*
Anales Inst. Oncol. "Angel H. Roffo"
*Anales del Instituto de Oncologia "Angel H. Roffo" *(Argentina)*
Anales Med. Cir.
*Anales de Medicina y Cirugia *(Spain)*
Anales Real Acad. Nacl. Med. (Madrid)
*Anales de la Real Academia Nacional de Medicina (Madrid) *(Spain)*
Anales Real Soc. Espan. Fis. Quim. (Madrid), Ser. A
*Anales de la Real Sociedad Espanola de Fisica y Quimica (Madrid), Serie A *(Spain)*
Anales Real Soc. Espan. Fis. Quim. (Madrid), Ser. B
*Anales de la Real Sociedad Espanola de Fisica y Quimica (Madrid), Serie B *(Spain)*
Anales Soc. Cient. Arg.
*Anales de la Sociedad Cientifica Argentina *(Argentina)*
Analyst
*Analyst, The *(England)*
Anat. Record
Anatomical Record, The *(U. S.)*
Anesthesiology
Anesthesiology *(U. S.)*
Angew. Chem.
Angewandte Chemie *(Germany)*
Angew. Chem. Intern. Ed. Engl.
Angewandte Chemie, International Edition in English *(U. S.–Germany)*

Angiologia (Barcelona)
*Angiologia (Barcelona) *(Spain)*
Angiology
Angiology *(U. S.)*
Ann. Acad. Sci. Fennicae, Ser. A II
Annales Academiae Scientiarum Fennicae, Series A II. Chemica *(Finland)*
Ann. Acad. Sci. Fennicae, Ser. A VI
*Annales Academiae Scientiarum Fennicae, Series A VI. Physica *(Finland)*
Ann. Allergy
*Annals of Allergy *(U. S.)*
Ann. Amelioration Plantes
Annales de l'Amelioration des Plantes *(France)*
Ann. Anat. Pathol.
*Annales d'Anatomie Pathologique *(France)*
Ann. Astrophys.
Annales d'Astrophysique *(France)*
Ann. Biochem. Exptl. Med. (Calcutta)
*Annals of Biochemistry and Experimental Medicine (Calcutta) *(India)*
Ann. Botany (London)
Annals of Botany (London) *(England)*
Ann. Chem.
Annalen der Chemie, Justus Liebigs *(Germany)*
Ann. Chim. (Rome)
Annali di Chimica (Rome) *(Italy)*
Ann. Chir. Gynaecol. Fenniae
*Annales Chirurgiae et Gynaecologiae Fenniae *(Finland)*
Ann. Chir. Plastique, Semaine Hop.
Annales de Chirurgie Plastique. Archives de la Ste Francaise de Chirurgie Plastique et Reconstructive. La Semaine des Hopitaux *(France)*
Ann. Conf. Eng. Med. Biol., 16th, Baltimore, 1963
Annual Conference on Engineering in Medicine and Biology, 16th [Conference], Baltimore, Nov. 18-20, 1963 *([U. S.])*
Annee Biol.
Annee Biologique, L' *(France)*
Ann. Endocrinol. (Paris)
Annales d'Endocrinologie (Paris) *(France)*
Ann. Fac. Sci. Univ. Toulouse Sci. Math. Sci. Phys.
Annales de la Faculte des Sciences de l'Universite de Toulouse pour les Sciences Mathematiques et les Sciences Physiques *(France)*
Ann. Genet.
Annales de Genetique *(France)*
Ann. Geophys.
Annales de Geophysique *(France)*
Ann. Human Genet.
Annales of Human Genetics *(England)*
Ann. Inst. Henri Poincare
*Annales de l'Institut Henri Poincare *(France)*
Ann. Inst. Pasteur
Annales de l'Institut Pasteur *(France)*
Ann. Inst. Tech. Batiment Trav. Publ.
Annales de l'Institut Technique du Batiment et des Travaux Publics *(France)*
Ann. Internal Med.
Annals of Internal Medicine *(U. S.)*
Ann. Intern. Geophys. Yr.
*Annals of the International Geophysical Year *(England)*
Ann. Med. Exptl. Biol. Fenniae (Helsinki)
Annales Medicinae Experimentalis et Biologiae Fenniae (Helsinki) *(Finland)*
Ann. Med. Internae Fenniae
Annales Medicinae Internae Fenniae *(Finland)*
Ann. Med. Nancy
Annales Medicales de Nancy *(France)*
Ann. Med. Navale (Rome)
Annali di Medicina Navale (Rome) (formerly Annali di Medicina Navale e Tropicale) *(Italy)*
Ann. Mines
Annales des Mines *(France)*
Ann. Nutr. Aliment.
Annales de la Nutrition et de l'Alimentation *(France)*
Ann. N. Y. Acad. Sci.
*Annals of the New York Academy of Sciences *(U. S.)*
Ann. Occupational Hyg.
*Annals of Occupational Hygiene *(England)*
Ann. Ostet. Ginecol.
*Annali di Ostetricia e Ginecologia *(Italy)*
Ann. Oto-Laryngol.
Annales d'Oto-Laryngologie, Les *(France)*
Ann. Otol. Rhinol. Laryngol.
Annals of Otology, Rhinology, and Laryngology *(U. S.)*
Ann. Paediat. Fenniae
*Annales Paediatriae Fenniae *(Finland)*
Ann. Paediat. Japon.
*Annales Paediatrici Japonici, Kioto Universitatis *(Japan)*
Ann. Pharm. Franc.
Annales Pharmaceutiques Francaises *(France)*
Ann. Phys. (N. Y.)
*Annals of Physics (New York) *(U. S.)*
Ann. Phys. (Paris)
*Annales de Physique (Paris) *(France)*
Ann. Physik
*Annalen der Physik *(Germany)*
Ann. Physiol. Vegetale Univ. Bruxelles
Annales de Physiologie Vegetale de l'Universite de Bruxelles *(Belgium)*
Ann. Polon. Math.
*Annales Polonici Mathematici *(Poland)*
Ann. Radioelec.
*Annales de Radioelectricite *(France)*
Ann. Radiol.
*Annales de Radiologie *(France)*
Ann. Rept. Japan. Assoc. Radiation Res. Polymers
Annual Report of the Japanese Association for Radiation Research on Polymers
see Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo
Ann. Rept. Natl. Inst. Genet. (Japan)
Annual Report of the National Institute of Genetics *(Japan)*
Ann. Rept. Radiation Center Osaka Prefect.
*Annual Report of the Radiation Center of Osaka Prefecture *(Japan)*
Ann. Rev. Astronomy Astrophys.
Annual Review of Astronomy and Astrophysics *(U. S.)*
Ann. Rev. Biochem.
Annual Review of Biochemistry *(U. S.)*
Ann. Rev. Med.
Annual Review of Medicine *(U. S.)*
Ann. Rev. Microbiol.
Annual Review of Microbiology *(U. S.)*
Ann. Rev. Nucl. Sci.
*Annual Review of Nuclear Science *(U. S.)*
Ann. Rev. Pharmacol.
Annual Review of Pharmacology *(U. S.)*
Ann. Rev. Phys. Chem.
*Annual Review of Physical Chemistry *(U. S.)*
Ann. Rev. Plant Physiol.
Annual Review of Plant Physiology *(U. S.)*
Ann. Rheumatic Diseases
*Annals of the Rheumatic Diseases *(England)*
Ann. Roy. Coll. Surg. Engl.
Annals of the Royal College of Surgeons of England *(England)*
Ann. Sanita Pubblica
Annali della Sanita Pubblica *(Italy)*
Ann. Sclavo
*Annali Sclavo *(Italy)*
Ann. Soc. Geol. Belg., Bull.
Annales de la Societe Geologique de Belgique, Bulletin *(Belgium)*
Ann. Soc. Sci. Bruxelles, Ser. I
*Annales de la Societe Scientifique de Bruxelles, Serie I *(Belgium)*
Ann. Surg.
Annals of Surgery *(U. S.)*
Ann. Univ. Mariae Curie-Sklodowska, Lublin-Polonia, Sect. AA
*Annales Universitatis Mariae Curie-Sklodowska, Lublin-Polonia, Sectio AA *(Poland)*
Ann. Univ. Mariae Curie-Sklodowska, Lublin-Polonia, Sect. D
*Annales Universitatis Mariae Curie-Sklodowska, Lublin-Polonia, Sectio D *(Poland)*
Ann. Univ. Mariae Curie-Sklodowska, Lublin-Polonia, Sect. E
*Annales Universitatis Mariae Curie-Sklodowska, Lublin-Polonia, Sectio E *(Poland)*
Anotaciones Pediat. (Medellin, Colombia)
*Anotaciones Pediatricas (Medellin, Colombia) *(Colombia)*
Antonie van Leeuwenhoek, J. Microbiol. Serol.
Antonie van Leeuwenhoek, Journal of Microbiology and Serology *(Netherlands)*

APCA (Air Pollution Control Assoc.) Abstr.
*APCA (Air Pollution Control Association) Abstracts *(U. S.)*
Appl. Microbiol.
*Applied Microbiology *(U. S.)*
Appl. Opt.
*Applied Optics *(U. S.)*
Appl. Phys. Letters
*Applied Physics Letters *(U. S.)*
Appl. Sci. Res., Sect. A
*Applied Scientific Research, Section A *(Netherlands)*
Appl. Sci. Res., Sect. B
*Applied Scientific Research, Section B *(Netherlands)*
Appl. Spectry.
*Applied Spectroscopy *(U. S.)*
Arbok Univ. Bergen, Mat.-Nat. Ser.
*Arbok for Universitetet i Bergen, Matematikk-Naturvitenskap Serie *(Norway)*
Arch. Anat. Microscop. Morphol. Exptl.
*Archives d'Anatomie Microscopique et de Morphologie Experimentale *(France)*
Arch. Automat. Telemech.
*Archiwum Automatyki i Telemechaniki *(Poland)*
Arch. Belges Med. Sociale, Hyg. Med. Travail Med. Legale
Archives Belges de Medecine Sociale, Hygiene, Medecine du Travail et Medecine Legale *(Belgium)*
Arch. Biochem. Biophys.
*Archives of Biochemistry and Biophysics *(U. S.)*
Arch. Biol. (Liege)
*Archives de Biologie (Liege) *(Belgium)*
Arch. Bioquim., Quim. Farm. Tucuman
*Archivos de Bioquimica, Quimica y Farmacia, Tucuman *(Argentina)*
Arch. Bodowy Maszyn
*Archiwum Bodowy Maszyn *(Poland)*
Arch. Dermatol.
Archives of Dermatology (formerly A.M.A. Archives of Dermatology) *(U. S.)*
Arch. Eisenhuettenw.
Archiv fuer das Eisenhuettenwesen *(Germany)*
Arch. Elektrotech.
*Archiwum Elektrotechniki *(Poland)*
Arch. Environ. Health
*Archives of Environmental Health (formerly A.M.A. Archives of Industrial Health) *(U. S.)*
Arch. Exptl. Pathol. Pharmakol.
Archiv fuer Experimentelle Pathologie und Pharmakologie, Naunyn-Schmiedebergs *(Germany)*
Arch. Geschwulstforsch.
Archiv fuer Geschwulstforschung *(Germany)*
Arch. Ges. Physiol.
Archiv fuer die Gesamte Physiologie des Menschen und der Tiere, Pfluegers *(Germany)*
Arch. Gornictwa
*Archiwum Gornictwa *(Poland)*
Arch. Hosp. Univ. (Havana)
*Archivos de Hospitales Universitarios (Havana) (formerly Archivos del Hospital Universitario) *(Cuba)*
Arch. Hosp. Vargas (Caracas)
*Archivos del Hospital Vargas (Caracas) *(Venezuela)*
Arch. Hutnictwa
*Archiwum Hutnictwa *(Poland)*
Arch. Hyg. Bakteriol.
*Archiv fuer Hygiene und Bakteriologie *(Germany)*
Arch. Immunol. Terapii Doswiadczalnej
Archiwum Immunologii i Terapii Doswiadczalnej
see **Arch. Immunol. Therap. Exptl.**
Arch. Immunol. Therap. Exptl.
*Archivum Immunologiae et Therapiae Experimentalis *(Poland)*
Arch. Interam. Rheumatol.
*Archives of Interamerican Rheumatology *(Brazil)*
Arch. Internal Med.
Archives of Internal Medicine (formerly A.M.A. Archives of Internal Medicine) *(U. S.)*
Arch. Intern. Pharmacodyn.
*Archives Internationales de Pharmacodynamie et de Therapie *(Belgium)*
Arch. Intern. Physiol. Biochim.
Archives Internationales de Physiologie et de Biochimie *(Belgium)*
Arch. Ital. Anat. Embriol.
Archivio Italiano de Anatomia e di Embriologia *(Italy)*
Arch. Ital. Biol.
*Archives Italiennes de Biologie *(Italy)*
Arch. Ital. Otol. Rinol. Laringol.
Archivio Italiano di Otologia, Rinologia e Laringologia *(Italy)*
Arch. Ital. Sci. Farmacol.
Archivo Italiano di Scienze Farmacologiche *(Italy)*
Arch. Ital. Urol.
Archivio Italiano di Urologia *(Italy)*
Arch. Klin. Exptl. Dermatol.
Archiv fuer Klinische und Experimentelle Dermatologie *(Germany)*
Arch. Maladies App. Digest. Maladies Nutr.
Archives des Maladies de l'Appareil Digestif et des Maladies de la Nutrition *(France)*
Arch. Maladies Profess. Med. Trav. Securite Sociale
Archives des Maladies Professionnelles de Medecine du Travail et de Securite Sociale *(France)*
Arch. Med. Mex.
*Archivos Medicos Mexicanos *(Mexico)*
Arch. Mikrobiol.
Archiv fuer Mikrobiologie *(Germany)*
Arch. Neurol.
Archives of Neurology *(U. S.)*
Arch. Ophthalmol.
Archiv fuer Ophthalmologie Vereinigt mit Archiv fuer Augenheilkunde, Albrecht von Graefes *(Germany)*
Arch. Ophthalmol. (Chicago)
Archives of Ophthalmology (Chicago) *(U. S.)*
Arch. Otolaryngol.
*Archives of Otolaryngology *(U. S.)*
Arch. Pathol.
Archives of Pathology (formerly A.M.A. Archives of Pathology) *(U. S.)*
Arch. Pathol. Anat. Physiol.
Archiv fuer Pathologische Anatomie und Physiologie und fuer Klinische Medizin, Virchows *(Germany)*
Arch. Peru. Patol. Clin. (Lima)
*Archivos Peruanos de Patologia y Clinica (Lima) *(Peru)*
Arch. Pharm.
Archiv der Pharmazie und Berichte der Deutschen Pharmazeutischen Gesellschaft (includes Mitteilungen der Deutschen Pharmazeutischen Gesellschaft und der Pharmazeutischen Gesellschaft der DDR) *(Germany)*
Arch. Physik. Therapie
Archiv fuer Physikalische Therapie, Balneologie und Klimatologie *(Germany)*
Arch. Roumaines Pathol. Exptl. Microbiol.
*Archives Roumaines de Pathologie Experimentale et de Microbiologie *(France)*
Arch. Sci. (Geneva)
*Archives des Sciences (Geneva) *(Switzerland)*
Arch. Sci. Med.
Archivio per le Scienze Mediche *(Italy)*
Arch. Soc. Estud. Clin. Habana
*Archivos de la Sociedad de Estudios Clinicos de la Habana *(Cuba)*
Arch. Surg.
Archives of Surgery *(U. S.)*
Arch. Venezolanos Patol. Trop. Parisitol. Med.
*Archivos Venezolanos de Patologia Tropical y Parasitologia Medica *(Venezuela)*
Arcispendale S. Anna Ferrara
Arcispedale S. Anna di Ferrara, L' *(Italy)*
Arcos (Brussels)
Arcos (Brussels) *(Belgium)*
Arctic
Arctic *(Canada)*
Argonne Natl. Lab. Rev.
*Argonne National Laboratory Reviews (supersedes News-Bulletin International (Argonne National Laboratory)) *(U. S.)*
Arhiv Hig. Rada Toksikol.
Arhiv za Higijenu Rada i Toksikologiju (formerly Arhiv za Higijenu Rada) *(Yugoslavia)*
Arhiv Poljoprivredne Nauke
Arhiv za Poljoprivredne Nauke *(Yugoslavia)*
Arkh. Anat., Gistol. i Embriol.
Arkhiv Anatomii, Gistologii i Embriologii *(U.S.S.R.)*
Arkh. Patol.
Arkhiv Patologii *(U. S. S. R.)*
Arkiv Fysik
*Arkiv for Fysik *(Sweden)*

Arkiv Fys. Seminar Trondheim
*Arkiv for det Fysiske Seminar i Trodheim *(Norway)*

Arkiv Kemi
*Arkiv for Kemi, Utgivet av Kungl. Svenska Vetenskapsakademien *(Sweden)*

Arquiv. Anat. Antropol. (Lisbon)
*Arquivo de Anatomia e Antropologia (Lisbon) *(Portugal)*

Arquiv. Brasil. Cardiol.
*Arquivos Brasileiros de Cardiologia *(Brazil)*

Arquiv. Dermatol. Sifilig. Sao Paulo
*Arquivos de Dermatologia e Sifiligrafia de Sao Paulo *(Brazil)*

Arquiv. I.B.I.T. (Inst. Brasil. Invest. Tuberc.)
*Arquivos do I.B.I.T. (Instituto Brasileiro para Investigacao da Tuberculose) *(Brazil)*

Arquiv. Mineiros Leprol.
*Arquivos Mineiros de Leprologia *(Brazil)*

Arquiv. Patol. (Lisbon)
*Arquivos de Patologia (Lisbon) *(Portugal)*

Arquiv. Tisiol.
*Arquivos de Tisiologia *(Portugal)*

Arthritis Rheumat.
*Arthritis and Rheumatism *(U. S.)*

Arzneimittel-Forsch.
Arzneimittel-Forschung *(Germany)*

Assoc. Belge Develop. Pacifique Energie At., Bull. Inform.
Association Belge pour le Development Pacifique de l'Energie Atomique, Bulletin d'Information *(Belgium)*

Astronaut. Acta
*Astronautica Acta *(Austria)*

Astronaut. Aeronaut.
*Astronautics & Aeronautics (formerly Astronautics and Aerospace Engineering) *(U. S.)*

Astronaut. Aerospace Eng.
Astronautics and Aerospace Engineering (combining Astronautics and Aerospace Engineering) *(U. S.)*

Astronautyka
*Astronautyka *(Poland)*

Astron. Tsirkulyar
Astronomicheskii Tsirkulyar *(U.S.S.R.)*

Astrophys. J.
*Astrophysical Journal, The *(U. S.)*

Astrophys. J., Suppl. Ser.
*Astrophysical Journal, The, Supplement Series *(U. S.)*

Astrophys. Norvegica
*Astrophysica Norvegica *(Norway)*

Ateneo Parmense
*Ateneo Parmense, L' *(Italy)*

At. Energ. (USSR)
Atomnaya Energiya *(U.S.S.R.)*

At. Energy Australia
*Atomic Energy in Australia *(Australia)*

At. Energy Rev.
*Atomic Energy Review *(Austria)*

At. Kozlemen.
*Atomki Kozlemenyek (formerly carried under the title: Magyar Tudomanyos Akademia Atommag Kutato Intezete (Debrecen). Kozlemenyek) *(Hungary)*

Atom
Atom *(England)*

Atomes (Paris)
Atomes (Paris) *(France)*

Atomics
*Atomics *(U. S.)*

Atomkernenergie
*Atomkernenergie (formerly Atomenergie) *(Germany)*

Atomlight
*Atomlight *(U. S.)*

Atompraxis
*Atompraxis *(Germany)*

Atomtech. Tajekoztato
*Atomtechnikai Tajekoztato *(Hungary)*

Atomwirtschaft
*Atomwirtschaft, Die *(Germany)*

Atoomenergie Haar Toepassingen
*Atoomenergie en Haar Toepassingen (formerly RCN Bulletin) *(Netherlands)*

At. Strom
*Atom und Strom *(Germany)*

Atti Accad. Nazl. Lincei, Rend., Classe Sci. Fis., Mat. Nat.
*Atti della Accademia Nazionale dei Lincei. Rendiconti, Classe di Scienze Fisiche, Matematiche e Naturali *(Italy)*

Atti Accad. Sci. Ist. Bologna, Classe Sci. Fis., Rend.
Atti della Accademia delle Scienze dell'Istituto di Bologna, Classe di Scienze Fisiche, Rendiconti *(Italy)*

Atti Accad. Sci., Lettere Arti Palermo, Pt. I
Atti della Accademia di Scienze, Lettere ed Arti di Palermo, Parte I *(Italy)*

Atti Accad. Sci. Torino: I. Classe Sci. Fis., Mat. Nat.
*Atti della Accademia delle Scienze di Torino. Part I. Classe Scienze Fisiche, Matematiche e Naturali *(Italy)*

Atti Assoc. Genet. Ital.
*Atti Associazone Genetica Italiana *(Italy)*

Atti Congr. Intern. Idrol. Climatol., Ischia, Italy, 1958
Atti del Congresso Internazionale di Idrologia e Climatologia, Ischia, Italy, Oct. 4-8, 1958 *(Italy)*

Atti, Congr. Nazl. Radiol. Med. Med. Nucl., 21, Bologna, 1960
Atti, Congresso Nazionale di Radiologia Medica e Medicina Nucleare, 21° [Congresso], Bologna, September 14–18, 1960 *(Italy)*

Atti Seminar. Mat. Fis. Univ. Modena
*Atti del Seminario Matematico e Fisico dell'Universita di Modena *(Italy)*

Atti Soc. Ital. Cardiol.
Atti della Societa Italiana di Cardiologia *(Italy)*

Atti Soc. Nat. Mat. Modena
*Atti della Societa dei Naturalisti e Matematici di Modena *(Italy)*

Atti Soc. Peloritana Sci. Fis. Mat. Nat.
Atti della Societa Peloritana di Scienze Fisiche Matematiche e Naturali *(Italy)*

Attualita Ostet. Ginecol.
Attualita di Ostetrica e Ginecologia *(Italy)*

Australasian Ann. Med.
Australasian Annals of Medicine *(Australia)*

Australasian Corrosion Eng.
Australasian Corrosion Engineering *(Australia)*

Australian J. Agr. Res.
Australian Journal of Agricultural Research *(Australia)*

Australian J. Appl. Sci.
*Australian Journal of Applied Science *(Australia)*

Australian J. Chem.
*Australian Journal of Chemistry *(Australia)*

Australian J. Dairy Technol.
Australian Journal of Dairy Technology, The *(Australia)*

Australian J. Exptl. Biol. Med. Sci.
Australian Journal of Experimental Biology and Medical Science, The *(Australia)*

Australian J. Phys.
*Australian Journal of Physics *(Australia)*

Australian J. Sci.
Australian Journal of Science, The *(Australia)*

Australian New Zealand J. Obstet. Gynaecol.
Australian and New Zealand Journal of Obstetrics and Gynaecology *(Australia)*

Automatizace (Prague)
Automatizace (Praque) *(Czechoslovakia)*

Automazione Automatismi
*Automazione e Automatismi *(Italy)*

Automazione Strumentazione
*Automazione e Strumentazione *(Italy)*

Autom. Control
Automatic Control *(U. S.)*

Avtomatika
Avtomatika *(Yugoslavia)*

Avtomat. i Telemekhan.
Avtomatika i Telemekhanika *(U.S.S.R.)*

Avtomat. Svarka
Avtomaticheskaya Svarka† *(Ukrainian S.S.R.)*

Azerb. Khim. Zh.
*Azerbaidzhanskii Khimicheskii Zhurnal *(Azerbaidzhan S.S.R.)*

Bacteriol. Rev.
*Bacteriological Reviews *(U. S.)*

Banyasz. Kut. Int. Kozlemen.
Banyaszati Kutato Intezet Kozlemenyei *(Hungary)*

Baskerville Chem. J., City Coll., N. Y.
Baskerville Chemical Journal, The City College of New York *(U. S.)*

Battelle Tech. Rev.
*Battelle Technical Review *(U. S.)*

Bauingenieur
Bauingenieur *(Germany)*

Beispiele Angew. Forsch.
Beispiele Angewandter Forschung *(Germany)*

Beitr. Pathol. Anat. Allgem. Pathol.
*Beitraege zur Pathologischen Anatomie und zur Allgemeinen Pathologie *(Germany)*

Beitr. Silikose-Forsch., Sonderband
Beitraege zur Silikose-Forschung, Sonderband *(Germany)*

Belgicatom, Assoc. Belge Develop. Pacifique Energie At., Bull. Inform.
Belgicatom, Association Belge pour le Developpement Pacifique de l'Energie Atomique, Bulletin d'Information (formerly Association Belge pour le Developpement Pacifique de l'Energie Atomique, Bulletin d'Information) *(Belgium)*

Belg. Tijdschr. Geneesk.
Belgisch Tijdschrift voor Geneeskunde *(Belgium)*

Bell System Tech. J.
Bell System Technical Journal, The *(U. S.)*

Ber. Abwassertech. Ver.
Berichte der Abwassertechnischen Vereinigung *(Germany)*

Ber. Bunsenges. Physik. Chem.
*Berichte der Bunsengesellschaft fuer Physikalische Chemie (formerly Zeitschrift fuer Elektrochemie) *(Germany)*

Ber. Deut. Botan. Ges.
Berichte der Deutschen Botanischen Gesellschaft *(Germany)*

Ber. Deut. Keram. Ges.
*Berichte der Deutschen Keramischen Gesellschaft e. V. *(Germany)*

Ber. Deut. Ophthalmol. Ges.
Berichte der Deutschen Ophthalmologischen Gesellschaft *(Germany)*

Berg. Huettenmaenn. Monatsh. Montan. Hochschule Leoben
Berg- und Huettenmaennische Monatshefte der Montanistischen Hochschule in Leoben *(Austria)*

Berlin. Med.
Berliner Medizin *(Germany)*

Ber. Oberhess. Ges. Natur- Heilk. Giessen, Naturw. Abt.
*Bericht der Oberhessischen Gesellschaft fuer Natur- und Heilkunde zu Giessen, Naturwissenschaftliche Abteilung *(Germany)*

Beton i Zhelezobeton
Beton i Zhelezobeton *(U.S.S.R.)*

Biblioa. Byull., Vses. Inst. Nauchn. i Tekhn. Inform.
Bibliograficheskii Byulleten, Vsesoyuznyi Institut Nauchnoi i Tekhnicheskoi Informatsii *(U.S.S.R.)*

Biochem. Biophys. Res. Commun.
*Biochemical and Biophysical Research Communications *(U. S.)*

Biochemistry
*Biochemistry *(U. S.)*

Biochemistry (USSR) (English Transl.)
*Biochemistry (USSR) (English Translation of Biokhimiya) *(U. S.)*

Biochem. J.
*Biochemical Journal *(England)*

Biochem. Pharmacol.
*Biochemical Pharmacology *(England)*

Biochem. Z.
Biochemische Zeitschrift *(Germany)*

Biochim. Appl.
Biochimica Applicata *(Italy)*

Biochim. Biophys. Acta
*Biochimica et Biophysica Acta *(U. S.)*

Biofizika
Biofizika† *(U.S.S.R.)*

Biokhim. Plodov i Ovoshchei, Akad. Nauk SSSR, Inst. Biokhim.
Biokhimiya Plodov i Ovoshchei, Akademiya Nauk SSSR, Institut Biokhimii imeni A. N. Bakha *(U.S.S.R)*

Biol. Bull.
Biological Bulletin, The *(U. S.)*

Biol. Neonatorum
*Biologia Neonatorum *(Switzerland)*

Biologia
Biologia *(Czechoslovakia)*

Biol. Plant., Acad. Sci. Bohemoslov.
Biologia Plantarum, Academia Scientiarum Bohemoslovenica *(Czechoslovakia)*

Biol. Zentr.
Biologisches Zentralblatt *(Germany)*

Biometrische Z.
Biometrische Zeitschrift *(Germany)*

Biophysik
*Biophysik *(Germany)*

Biophys. J.
*Biophysical Journal *(U. S.)*

Biophys. J., Suppl.
*Biophysical Journal, Supplement *(U. S.)*

Biopolymers Symp.
Biopolymers Symposia *(U. S.)*

Biotechnol. Bioeng.
Biotechnology and Bioengineering (formerly Journal of Biochemical and Microbiological Technology and Engineering) *(England)*

Bitki Koruma Bulteni
Bitki Koruma Bulteni *(Turkey)*

Blast Furnace Steel Plant
Blast Furnace and Steel Plant *(U. S.)*

Blech
Blech *(Germany)*

Blood
*Blood. The Journal of Hematology *(U. S.)*

Blut
Blut *(Germany)*

Boei Eisei
*Boei Eisei (National Defense Medical Journal) *(Japan)*

Bol. Asoc. Med. Puerto Rico
*Boletin de la Asociacion Medica de Puerto Rico *(Puerto Rico)*

Bol. Biblioteca Nacl.
*Boletin de la Biblioteca Nacional *(Mexico)*

Bol. Fac. Ing. Agri-Mensura Montevideo
*Boletin de la Facultad de Ingenieria y Agri-Mensura de Montevideo *(Uruguay)*

Bol. Hosp. Oftalmol. Nuestra Senora de la Luz
*Boletin del Hospital Oftalmologico de Nuestra Senora de la Luz *(Mexico)*

Bol. Inst. Estud. Med. Biol. (Mex.)
*Boletin del Instituto de Estudios Medicos y Biologicos *(Mexico)*

Bol. Junta Control Energia At. (Peru)
*Boletin de la Junta de Control de Energia Atomica (formerly Boletin de Informaciones de la Junta de Control de Energia Atomica) *(Peru)*

Boll. Assoc. Nazl. Ital. Ing. Nucl.
*Bollettino dell Associazione Nazionale Italiana di Ingegneria Nucleare *(Italy)*

Boll. Ist. Sieroterap. Milan.
*Bollettino dell'Istituto Sieroterapico Milanese *(Italy)*

Boll. Oculist.
Bollettino d'Oculistica *(Italy)*

Bol. Soc. Cubana Dermatol. Sifiliog.
*Boletin de la Sociedad Cubana de Dermatologia y Sifilografia *(Cuba)*

Boll. Soc. Ital. Biol. Sper.
Bollettino della Societa Italiana di Biologia Sperimentale *(Italy)*

Boll. Soc. Ital Patol.
Bollettino della Societa Italiana di Patologia *(Italy)*

Boll. Zool.
Bollettino di Zoologia *(Italy)*

Bol. Ofic. Sanit. Panam.
Boletin de la Oficina Sanitaria Panamericana *(U. S.)*

Bol. Soc. Botan. Mex.
*Boletin de la Sociedad Botanica de Mexico *(Mexico)*

Bol. Soc. Med. Centro Materno "Gral. Maximino Avila Camacho"
*Boletin de la Sociedad Medica del Centro Materno "Gral. Maximino Avila Camacho" *(Mexico)*

Bol. Trab. Soc. Cir. Buenos Aires
*Boletines y Trabajos; Sociedad de Cirugia de Buenos Aires *(Argentina)*

Bol. Univ. Parana, Fis. Teorica
*Boletim da Universidade do Parana, Fisica Teorica *(Brazil)*

Bombay Technologist
*Bombay Technologist *(India)*

Boravoqyaszati Venerol. Szemle
Boravoqyaszati es Venerologiai Szemle *(Hungary)*

Botan. Bull. Acad. Sinica (Taiwan)
*Botanical Bulletin of Academia Sinica (Taiwan) *(China)*

Botan. Gaz.
*Botanical Gazette *(U. S.)*

Bratislav. Lekarske Listy
Bratislavske Lekarske Listy *(Czechoslovakia)*

Brennstoff-Chem.
Brennstoff-Chemie *(Germany)*

Brennstoff-Waerme-Kraft
*Brennstoff-Waerme-Kraft *(Germany)*
Brigham Young Univ. Sci. Bull., Biol. Ser.
*Brigham Young University Science Bulletin, Biological Series *(U. S.)*
Brit. Chem. Eng.
*British Chemical Engineering *(England)*
Brit. Columbia Med. J.
*British Columbia Medical Journal *(Canada)*
Brit. Commun. Electron.
British Communications & Electronics *(England)*
Brit. Heart J.
British Heart Journal *(England)*
Brit. J. Appl. Phys.
*British Journal of Applied Physics *(England)*
Brit. J. Cancer
*British Journal of Cancer *(England)*
Brit. J. Exptl. Pathol.
British Journal of Experimental Pathology, The *(England)*
Brit. J. Haematol.
British Journal of Haematology *(England)*
Brit. J. Ind. Med.
British Journal of Industrial Medicine *(England)*
Brit. J. Non-Destructive Testing
British Journal of Non-Destructive Testing *(England)*
Brit. J. Nutr.
British Journal of Nutrition, The *(England)*
Brit. J. Plastic Surg.
British Journal of Plastic Surgery *(Scotland)*
Brit. J. Radiol.
*British Journal of Radiology *(England)*
Brit. J. Surg.
British Journal of Surgery, The *(England)*
Brit. Med. Bull.
British Medical Bulletin *(England)*
Brit. Med. J.
British Medical Journal, The *(England)*
Brit. Vet. J.
British Veterinary Journal, The *(England)*
Brot Gebaeck
Brot und Gebaeck *(Germany)*
Brown Boveri Rev.
*Brown Boveri Review, The *(Switzerland)*
Bruns' Beitr. Klin. Chir.
Bruns' Beitraege zur Klinischen Chirurgie *(Germany)*
Budownictwo Okretowe
Budownictwo Okretowe *(Poland)*
Bulgar. Akad. Nauk. Fiz. Mat. Spisanie
Bulgarska Akademiya na Naukite. Fizicheski Institut. Fiziko-Matematicheska Spisanie *(Bulgaria)*
Bul. Inst. Politeh. Bucuresti
*Buletinul Institutului Politehnic Bucuresti *(Romania)*
Bul. Inst. Politeh. Iasi
*Buletinul Institutului Politehnic din Iasi *(Romania)*
Bull. Acad. Natl. Med. (Paris)
Bulletin de l'Academie Nationale de Medecine (Paris) *(France)*
Bull. Acad. Polon. Sci., Ser. Sci. Biol.
*Bulletin de l'Academie Polonaise des Sciences, Serie des Sciences Biologiques *(Poland)*
Bull. Acad. Polon. Sci., Ser. Sci. Chim.
*Bulletin de l'Academie Polonaise des Sciences, Serie des Sciences Chimiques *(Poland)*
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*Bulletin de l'Academie Polonaise des Sciences, Serie des Sciences Geologiques et Geographiques *(Poland)*
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Bulletin de l'Academie Veterinaire de France *(France)*
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Bulletin of the Aeronautical Research Institute, University of Tokyo
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Bulletin, American College of Surgeons *(U. S.)*
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Bulletin de l'Association Francaise pour l'Etude du Cancer *(France)*
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Bulletin of the Atmospheric Radioactivity (Japan)
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Bulletin of the Boris Kidrich Institute of Nuclear Sciences *(Yugoslavia)*
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*Bulletin of the Chemical Society of Japan *(Japan)*
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*Bulletin de la Classe des Sciences, Academie Royale de Belgique *(Belgium)*
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Bulletin des Eidgenoessisches Gesundheitsamtes, Beilage B *(Switzerland)*
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Bulletin of the Electrotechnical Laboratory (Tokyo)
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see Miyazaki Daigaku Nogakubu, Kenkyu Jiho
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Bulletin of the Geological Society of America *(U. S.)*
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*Bulletin of the Heart Institute, Japan *(Japan)*
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*Bulletin of the Hospital for Joint Diseases *(U. S.)*
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*Bulletin d'Information sur les Applications Industrielles des Radioelements. Supplement au Bulletin d'Information de l'A.T.E.N. (Association Technique pour l'Energie Nucleaire) *(France)*
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*Bulletin d'Information de l'Association Belge pour le Developpement Pacifique de l'Energie Atomique *(Belgium)*
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*Bulletin d'Information A.T.E.N. (Association Technique pour l'Energie Nucleaire) *(France)*
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*Bulletin d'Information Scientifique et Techniaue (Paris) *(France)*
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Bulletin of the Institute of Balneotherapeutics (Oh-ita-Ken, Japan). The
see Onken Kiyo
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*Bulletin of the Institute of Chemistry, Academia Sinica *(China)*
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*Bulletin of the Institute for Chemical Research, Kyoto University *(Japan)*
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Bulletin de l'Institut Oceanographique *(Monaco)*
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Bulletin of the Institute of Public Health (Tokyo)
see Koshu Eiseiin Kenkyu Hokoku
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Bulletin of Marine Science (Japan)
see Soyo-Kaiyokagaku
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Bulletin of Mathematical Biophysics *(U. S.)*
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Bulletin of the Meiji College of Pharmacy *(Japan)*
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*Bulletin of the Mineral Research and Exploration Institute of Turkey, Foreign Edition *(Turkey)*
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Bulletin of the New York Academy of Medicine *(U. S.)*

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Bulletin of the Osaka Industrial Research Institute
see Osaka Kogyo Gijutsu Shikensho Kiho

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Bulletin of the Parenteral Drug Association *(U. S.)*

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Bulletin of the Post-Graduate Committee in Medicine, University of Sydney *(Australia)*

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*Bulletin on Rheumatic Diseases *(U. S.)*

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*Bulletin der Schweizerischen Akademie der Medizinischen Wissenschaften *(Switzerland)*

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*Bulletin Scientifique, Conseil des Academies de la RPF Yougoslavie *(Yugoslavia)*

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Bulletin of Scientific and Engineering Research Laboratory, Waseda University
see Waseda Daigaku Rikogaku Kenkyusho Hokoku

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Bulletin de la Societe Belge de Physique, Serie II *(Belgium)*

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*Bulletin des Societes Chimiques Belges *(Belgium)*

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Bulletin de la Societe de Chimie Biologique *(France)*

Bull. Soc. Chim. France
*Bulletin de la Societe Chimique de France *(France)*

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Bulletin de la Societe Francaise de Ceramique *(France)*

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Bulletin de la Societe Francaise de Dermatologie et de Syphiliographie *(France)*

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*Bulletin de la Societe Francaise de Mineralogie et de Cristallographie *(France)*

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Bulletin Mensuel: Societe de Medecine Militaire Francaise *(France)*

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*Bulletin de la Societe Royale Belge de Gynecologie et d'Obstetrique *(Belgium)*

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*Bulletin de la Societe Royale des Sciences de Liege *(Belgium)*

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*Bulletin de la Societe Scientifique de Bretagne *(France)*

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*Bulletin de la Societe Vaudoise des Sciences Naturelles *(Switzerland)*

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Bulletin of the Textile Research Institute of Japanese Government
see Kogyo Gijutsuin Sen'i Kogyo Shikensho Kenkyu Hokoku

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*Bulletin of the Tokyo Institute of Technology, Special Number *(Japan)*

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Bulletin de l'Union Internationale contre la Tuberculose *(France)*

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Bulletin of the World Health Organization *(U. S.)*

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Bunseki Kagaku
*Bunseki Kagaku (Japan Analyst) *(Japan)*

Burma Med. J.
*Burma Medical Journal *(Burma)*

Business At. Rept., Suppl.
Business Atomics Report, Supplement *(U. S.)*

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Byul. Eksperim. Biol. i Med.
Byulleten Eksperimental'noi Biologii i Meditsiny† *(U.S.S.R.)*

Byull. Izobret. i Tovarnykh Znakov
Byulleten Izobretenii i Tovarnykh Znakov (formerly Byulleten Izobretenii) *(U.S.S.R.)*

Byul. Mosk. Obshchestva Ispytatelei Prirody, Otd. Biol.
Byulleten Moskovskoqo Obshchestva Ispytatelei Prirody, Otdel Biologicheskii *(U.S.S.R.)*

Byul. Nauchn.-Tekhn. Inform. Min. Geol. i Okhrany Nedr SSSR
Byulleten Nauchno-Tekhnicheskoi Informatsii Ministerstva Geologii i Okhrany Nedr SSSR *(U.S.S.R.)*

Cahiers Med. Vet.
Cahiers de Medecine Veterinaire, Les *(France)*

Cahiers Phys.
*Cahiers de Physique *(France)*

Calcolo
Calcolo *(Italy)*

Calif. Agr.
California Agriculture *(U. S.)*

Calif. Med.
*California Medicine *(U. S.)*

Calore
*Calore, Il *(Italy)*

Cancer
*Cancer *(U. S.)*

Cancer Chemotherapy Rept.
Cancer Chemotherapy Reports *(U. S.)*

Cancer Res.
*Cancer Research *(U. S.)*

Can. Chem. Process.
*Canadian Chemical Processing *(Canada)*

Can. Food Ind.
Canadian Food Industries *(Canada)*

Can. Geophys. Bull.
*Canadian Geophysical Bulletin *(Canada)*

Can. Geotech. J.
Canadian Geotechnical Journal *(Canada)*

Can. Hosp.
Canadian Hospital *(Canada)*

Can. J. Animal Sci.
Canadian Journal of Animal Science *(Canada)*

Can. J. Biochem.
*Canadian Journal of Biochemistry (supersedes in part Canadian Journal of Biochemistry and Physiology) *(Canada)*

Can. J. Botany
Canadian Journal of Botany *(Canada)*

Can. J. Chem.
*Canadian Journal of Chemistry *(Canada)*

Can. J. Chem. Eng.
*Canadian Journal of Chemical Engineering (formerly Canadian Journal of Technology) *(Canada)*

Can. J. Genet. Cytol.
*Canadian Journal of Genetics and Cytology *(Canada)*

Can. J. Math.
*Canadian Journal of Mathematics *(Canada)*

Can. J. Med. Technol.
*Canadian Journal of Medical Technology, The *(Canada)*

Can. J. Microbiol.
*Canadian Journal of Microbiology *(Canada)*

Can. J. Phys.
*Canadian Journal of Physics *(Canada)*

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Can. J. Public Health
*Canadian Journal of Public Health *(Canada)*

Can. J. Zool.
*Canadian Journal of Zoology *(Canada)*

Can. Machinery Metalworking
Canadian Machinery and Metalworking *(Canada)*

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*Canadian Mathematical Bulletin *(Canada)*

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*Canadian Medical Association Journal, The *(Canada)*

Can. Met. Quart.
*Canadian Metallurgical Quarterly *(Canada)*

Can. Mining J.
*Canadian Mining Journal *(Canada)*
Cannonade
Cannonade *(U. S.)*
Can. Nucl. Technol.
*Canadian Nuclear Technology *(Canada)*
Can. Nurse
Canadian Nurse *(Canada)*
Can. Patent Office Record
*Canadian Patent Office Record *(Canada)*
Can. Power Engr.
*Canadian Power Engineer *(Canada)*
Can. Welder Fabricator
Canadian Welder & Fabricator *(Canada)*
Carbon
Carbon *(England)*
Cardiologia
*Cardiologia *(Switzerland)*
Caryologia
*Caryologia *(Italy)*
Casopis Lekaru Ceskych
Casopis Lekaru Ceskych *(Czechoslovakia)*
Cement Concrete
Cement and Concrete
see **Semento Konkuriito**
CENUSA (Bol. Centrales Nucl., Soc. Anon.)
*CENUSA (Boletin de Centrales Nucleares, Sociedad Anonima) *(Spain)*
Cereal Chem.
Cereal Chemistry *(U. S.)*
CERN Courier
*CERN Courier *(Switzerland)*
Cesk. Casopis Fys.
*Ceskoslovensky Casopis pro Fysiku *(Czechoslovakia)*
Cesk. Dermatol.
Ceskoslovenska Dermatologie *(Czechoslovakia)*
Cesk. Farm.
Ceskoslovenska Farmacie *(Czechoslovakia)*
Cesk. Fysiol.
Ceskoslovenska Fysiologie *(Czechoslovakia)*
Cesk. Hyg.
Ceskoslovenska Hygiena *(Czechoslovakia)*
Cesk. Neurol.
Ceskoslovenska Neurologie *(Czechoslovakia)*
Cesk. Ofthalmol.
Ceskoslovenska Ofthalmologie *(Czechoslovakia)*
Cesk. Radiol.
Ceskoslovenska Radiologie (formerly Ceskoslovenska Rentgenologie) *(Czechoslovakia)*
Cesk. Rentgenol.
Ceskoslovenska Rentgenologie *(Czechoslovakia)*
Cesk. Zdravotnictvi
Ceskoslovenski Zdravotnictvi *(Czechoslovakia)*
Ceylon Med. J.
Ceylon Medical Journal *(Ceylon)*
Chem. Anal. (Warsaw)
*Chemia Analityczna (Warsaw) *(Poland)*
Chem. Ber.
Chemische Berichte *(Germany)*
Chem. Bull. (Peking)
Chemical Bulletin (Peking)
see **Hua Hsueh Tung Pao**
Chem. Can.
*Chemistry in Canada *(Canada)*
Chem. Chem. Ind. (Japan)
Chemistry and Chemical Industry (Japan)
see **Kagaku to Kogyo (Tokyo)**
Chem. Eng.
Chemical Engineering with Chemical & Metallurgical Engineering *(U. S.)*
Chem. Eng. News
Chemical and Engineering News *(U. S.)*
Chem. Eng. Progr.
*Chemical Engineering Progress *(U. S.)*
Chem. Eng. Progr., Symp. Ser.
Chemical Engineering Progress, Symposium Series *(U. S.)*
Chem. Engr. (London)
Chemical Engineer, The (London) (included in Transactions of the Institution of Chemical Engineers (London)) *(England)*
Chem. Eng. Sci.
*Chemical Engineering Science *(U. S.)*
Chem. High Polymers (Tokyo)
Chemistry of High Polymers (Tokyo)
see **Kobunshi Kagaku**
Chemiker Ztg.
Chemiker Zeitung *(Germany)*
Chem. Ind. (London)
*Chemistry & Industry (London) *(England)*
Chem. Ind. (Tokyo)
Chemical Industry (Tokyo)
see **Kagaku Kogyo**
Chem.-Ingr.-Tech.
Chemie-Ingenieur-Technik *(Germany)*
Chemist-Analyst
*Chemist-Analyst, The *(U. S.)*
Chemistry
Chemistry *(U. S.)*
Chem. Listy
*Chemicke Listy *(Czechoslovakia)*
Chemotherapia
Chemotherapia *(Switzerland)*
Chem. Process Eng.
*Chemical & Process Engineering (including Atomic World) *(England)*
Chem. Rev.
*Chemical Reviews *(U. S.)*
Chem. Stosowana, Ser. A.
*Chemia Stosowana, Seria A *(Poland)*
Chem. Stosowana, Ser. B
*Chemia Stosowana, Seria B *(Poland)*
Chem. Tech. (Leipzig)
*Chemische Technik, VEB Deutscher Verlag fuer Grundstoffindustrie, Leipzig *(Germany)*
Chem. Weekblad
Chemische Weekblad *(Netherlands)*
Chem. Zvesti
Chemicke Zvesti *(Czechoslovakia)*
Chim. Anal.
*Chimie Analytique (Paris) *(France)*
Chim. Chronika (Athens, Greece)
Chimika Chronika (Athens, Greece) *(Greece)*
Chimia (Aarau)
*Chimia (Aarau) *(Switzerland)*
Chim. Ind. (Milan)
Chimica, La, e l'Industria (Milan) *(Italy)*
Chim. Ind. (Paris)
Chimie & Industrie (Paris) *(France)*
Chinese J. Phys. (Taiwan)
*Chinese Journal of Physics (Taiwan) *(China)*
Chromosoma
*Chromosoma *(Germany)*
Chron. World Health Organ.
Chronical of the World Health Organization *(Switzerland)*
Chung Kuo K'o Hsueh
Chung Kuo K'o Hsueh
see **Sci. Scinica (Peking)**
Ciencia Tec. (Buenos Aires)
*Ciencia y Tecnica (Buenos Aires) *(Argentina)*
Cir. Cirujanos
*Cirugia y Cirujanos *(Mexico)*
Circulation
Circulation *(U. S.)*
Cir. Ginecol. Urol.
*Cirugia, Ginecologia, y Urologia *(Spain)*
Civil Eng. (N. Y.)
Civil Engineering (New York) *(U. S.)*
Clin. All-round (Osaka)
Clinics All-round (Osaka)
see **Soga Rinsho**
Clin. Chem.
*Clinical Chemistry *(U. S.)*
Clin. Chim. Acta
*Clinica Chimica Acta *(Netherlands)*
Clin. Ostet. Ginecol.
Clinica Ostetrica e Ginecologica *(Italy)*
Clin. Pharmacol. Therap.
Clinical Pharmacology and Therapeutics *(U. S.)*
Clin. Radiol.
Clinical Radiology *(Scotland)*
Clin. Radiol. (Japan)
Clinical Radiology (Japan)
see **Rinsho Hoshasen**

Clin. Res.
*Clinical Research *(U. S.)*
Clin. Sci.
Clinical Science *(England)*
Clin. Surg. (Japan)
Clinical Surgery (Japan)
see Rinsho Geka
CNFRA (Comite Natl. Francais Rech. Antarctiques)
CNFRA (Comite National Francais des Recherches Antarctiques) *(France)*
Cobalt
*Cobalt *(Belgium) (U. S.)*
Cold Spring Harbor Symp. Quant. Biol.
Cold Spring Harbor Symposia on Quantitative Biology *(U. S.)*
Collection Czech. Chem. Commun.
*Collection of Czechoslovak Chemical Communications *(Czechoslovakia)*
Colliery Guardian
Colliery Guardian, The *(England)*
Colloq. Intern. Centre Natl. Rech. Sci. (Paris)
Colloques Internationaux de Centre National de la Recherche Scientifique (Paris) *(France)*
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Combust., Chauffage Ind. Mod.
Combustion, le Chauffage Industriel Moderne *(France)*
Combustion
Combustion *(U. S.)*
Comit. Nazl. Energia Nucl., Notiziario
*Comitato Nazionale per l'Energia Nucleare, Notiziario *(Italy)*
Commun. ACM (Assoc. Computing Machinery)
Communications of the ACM (Association for Computing Machinery) *(U. S.)*
Com. Nacl. Energia Nucl. (Mex.), [Publ.]
Comision Nacional de Energia Nuclear Mexico, [Publicacion] *(Mexico)*
Compensation Med.
Compensation Medicine *(U. S.)*
Compt. Rend.
*Comptes Rendus Hebdomadaires des Seances de l'Academie des Sciences *(France)*
Compt. Rend. Acad. Agr. France
Comptes Rendus des Seances de l'Academie d'Agriculture de France *(France)*
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Comptes Rendus de l'Academie Bulgare des Sciences *(Bulgaria)*
Compt. Rend. Rech. (Inst. Encour. Rech. Sci. Ind. Agr.)
Comptes Redus de Recherches (Institut pour l'Encouragement de la Recherche Scientifique dans l'Industrie et l'Agriculture) *(Belgium)*
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*Comptes Rendus des Seances de la Societe de Biologie et de ses Filiales *(France)*
Compt. Rend. Soc. Franc. Gynecol.
*Comptes Rendus de la Societe Francaise de Gynecologie *(France)*
Compt. Rend. Trav. Lab. Carlsberg
Comptes Rendus des Travaux du Laboratoire Carlsberg *(Denmark)*
Comun. Acad. Rep. Populare Romine
Comunicarile Academiei Republicii Populare Romine *(Romania)*
Concours Med.
Concours Medical *(France)*
Conn. Med.
Connecticut Medicine *(U. S.)*
Contemp. Phys.
*Contemporary Physics *(England)*
Contrib. Cient., Univ. Buenos Aires, Fac. Cienc. Exact. Nat., Ser. Fis.
*Contribuciones Cientificas, Universidad de Buenos Aires, Faculdad de Ciencias Exactas y Naturales, Serie Fisica *(Argentina)*
Corrosion
*Corrosion *(U. S.)*
Corrosion Anti-Corrosion
*Corrosion et Anti-Corrosion *(France)*
Corrosion Sci.
*Corrosion Science *(U. S.)*
Croat. Chem. Acta
*Croatica Chemica Acta *(Yugoslavia)*
Crop Sci.
Crop Science *(U. S.)*
Cryogenics
*Cryogenics *(England)*
Current Eng. Practice
Current Engineering Practice *(India)*
Current Sci. (India)
*Current Science *(India)*
Cytogenetics
*Cytogenetics *(Switzerland)*
Cytologia (Tokyo)
Cytologia (Tokyo) *(Japan)*
Czech. J. Phys.
*Czechoslovak Journal of Physics *(Czechoslovakia)*
Dairy Eng.
Dairy Engineering *(England)*
Danish Med. Bull.
*Danish Medical Bulletin *(Denmark)*
Dansk Tidsskr. Farm.
Dansk Tidsskrift for Farmaci *(Denmark)*
Dechema Monograph.
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Defence Sci. J. (New Delhi)
Defence Science Journal (New Delhi) *(India)*
Delaware Med. J.
Delaware Medical Journal *(U. S.)*
Denki Gakkai Zasshi
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Denki Shikensho Iho
*Denki Shikensho Iho (Bulletin of the Electrotechnical Laboratory (Tokyo)) *(Japan)*
Dermatologica
*Dermatologica *(Switzerland)*
Deut. Apotheker-Zta.
Deutsche Apotheker-Zeitung Vereiniat mit Sueddeutsche Apotheker-Zeitung *(Germany)*
Deut. Gesundheitsw.
Deutsche Gesundheitswesen, Das *(Germany)*
Deut. Lebensm.-Rundschau
Deutsche Lebensmittel-Rundschau *(Germany)*
Deut. Med. J.
Deutsches Medizinisches Journal *(Germany)*
Deut. Med. Wochschr.
Deutsche Medizinische Wochenschrift *(Germany)*
Deut. Zahnaerztl. Z.
Deutsche Zahnaerztliche Zeitschrift *(Germany)*
Deut. Z. Ges. Gerichtl. Med.
Deutsche Zeitschrift fuer die Gesamte Gerichtliche Medizin *(Germany)*
Deut. Z. Nervenheilk.
Deutsche Zeitschrift fuer Nervenheilkunde *(Germany)*
Deut. Z. Verdauungs- Stoffwechselkrankh.
*Deutsche Zeitschrift fuer Verdauungs-und Stoffwechselkrankheiten *(Germany)*
Develop. Biol.
*Developmental Biology *(U. S.)*
Diabetes
Diabetes *(U. S.)*
Dia Med. (Buenos Aires)
Dia Medico (Buenos Aires) *(Argentina)*
Dielectrics
Dielectrics *(England)*
Discovery
*Discovery *(England)*
Discussions Faraday Soc.
*Discussions of the Faraday Society *(England)*
Diseases Chest
Diseases of the Chest *(U. S.)*

Diseases Nervous System
Diseases of the Nervous System *(U. S.)*
Dissertation Abstr.
*Dissertation Abstracts *(U. S.)*
Dobutsugaku Zasshi
Dobutsugaku Zasshi (The Zoological Magazine) *(Japan)*
Dokl. Akad. Nauk Belorussk. SSR
Doklady Akademii Nauk Belorusskoi SSR *(Belorussian S.S.R.)*
Dokl. Akad. Nauk SSSR
*Doklady Akademii Nauk SSSR† *(U.S.S.R.)*
Dokl. Vses. Akad. Sel'skokhoz. Nauk
Doklady Vsesoyuznoi Akademii Sel'skokhozyaistvennykh Nauk imeni V. I. Lenina *(U.S.S.R.)*
Dopovidi Akad. Nauk Ukr. RSR
*Dopovidi Akademii Nauk Ukrains'koi RSR *(Ukrainian S.S.R.)*
Dopovidi L'vivs'k. Derzh. Univ.
Dopovidi ta Povidomlennya, L'vivs'kii Derzhavnii Universitet imeni I. Fronka *(Ukrainian S.S.R.)*
Duodecim
Duodecim *(Finland)*
Eau
Eau, L' *(France)*
Ecloage Geol. Helv.
Ecloage Geologicae Helvetiae *(Switzerland)*
Ecology
Ecology *(U. S.)*
Econ. Botany
Economic Botany *(U. S.)*
Econ. Geol.
*Economic Geology and the Bulletin of the Society of Economic Geologists *(U. S.)*
EEI (Edison Elec. Inst.) Bull.
EEI (Edison Electric Institute) Bulletin *(U. S.)*
Effluent Water Treat. J.
Effluent & Water Treatment Journal *(England)*
Eisei Shikensho Hokoku
Eisei Shikensho Hokoku (Bulletin of National Institute of Hygienic Sciences) *(Japan)*
Eiyo To Shokuryo
Eiyo To Shokuryo—Eiyo Shokuryo Gakkaishi (Journal of the Japanese Society of Food and Nutrition) *(Japan)*
Ekol. Polska, Ser. B
*Ekologia Polska, Seria B *(Poland)*
Eksperim. Med. i Morfol.
Eksperimentalna Meditsina i Morfologiya *(Bulgaria)*
Ekstraktsiya, Teoriya, Primenenie, App. Sb. Statei
Ekstraktsiya, Teoriya, Primenenie, Apparatura, Sbornik Statei *(U.S.S.R.)*
Elec. Design News
Electrical Design News *(U. S.)*
Elec. Eng.
Electrical Engineering *(U. S.)*
Elec. Export Rev.
*Electrical Export Review *(England)*
Elec. Power (Kyoto)
Electrical Power (Kyoto) *(Japan)*
Elec. Rev.
Electrical Review *(England)*
Electricite
*Electricite *(France)*
Electrochem. Technol.
Electrochemical Technology *(U. S.)*
Electrochim. Acta
*Electrochimica Acta *(U. S.)*
Electron. Design
Electronic Design *(U. S.)*
Electron. Eng.
*Electronic Engineering Incorporating Electronics, Television and Short Wave World *(England)*
Electronics
*Electronics *(U. S.)*
Electronics (Japan)
Electronics (Japan)
see *Erekutoronikusu*
Electron. Ind.
Electronic Industries *(U. S.)*
Electron. Power
Electronics and Power *(England)*
Electron. Record
*Electronics Record *(England)*
Electron. World
Electronics World *(U. S.)*
Elec. World
Electrical World *(U. S.)*
Elektrichestvo
Elektrichestvo† *(U.S.S.R.)*
Elektrotech. Maschinenbau
Elektrotechnik und Maschinenbau *(Germany)*
Elektrotech. Obzor
Elektrotechniky Obzor *(Czechoslovakia)*
Elektrotech. Z.
Elektrotechnische Zeitschrift *(Germany)*
Elektrotech. Z. B.
Elektrotechnische Zeitschrift. Ausgabe B *(Germany)*
Elektrotekhnika
Elektrotekhnika (formerly Vestnik Elektropromyshlennosti) *(U.S.S.R.)*
Elelm. Ipar
Elelmezesi Ipar *(Hungary)*
Embryologia (Nagoya)
Embryologia (Nagoya) *(Japan)*
Endeavour
*Endeavour *(England)*
Endocrinology
*Endocrinology *(U. S.)*
Endocrinol. Sci. Costituzione
Endocrinologia e Scienza della Costituzione *(Italy)*
Energia Atomtech.
*Energia es Atomtechnika *(Hungary)*
Energia Elettrica
Energia Elettrica, L' *(Italy)*
Energia Nucl. (Lisbon)
Energia Nuclear (Lisbon) *(Portugal)*
Energia Nucl. (Madrid)
*Energia Nuclear (Madrid) *(Spain)*
Energia Nucl. (Milan)
*Energia Nucleare (Milan) *(Italy)*
Energie Nucl.
*Energie Nucleaire *(France)*
Energy Intern.
*Energy International *(England)*
Eng. Boiler House Rev.
Engineering and Boiler House Review *(England)*
Engelhard Ind., Tech. Bull.
Engelhard Industries, Inc., Technical Bulletin *(U. S.)*
Engineer
Engineer, The *(England)*
Entomol. Obozrenie
Entomologicheskoe Obozrenie *(U.S.S.R.)*
Enzymologia
*Enzymologia *(Netherlands)*
Epatologia
Epatologia *(Italy)*
Erekutoronikusu
Erekutoronikusu (Electronics (Japan)) *(Japan)*
Ergeb. Allgem. Pathol. Pathol. Anat.
*Ergebnisse der Allgemeinen Pathologie und Pathologischen Anatomie *(Germany)*
Erlanger Geol. Abhandl.
Erlanger Geologische Abhandlungen *(Germany)*
Ernaehrungsforschung
Ernaehrungsforschung *(Germany)*
Euphytica
Euphytica *(Netherlands)*
Euratom Bull.
*Euratom Bulletin (Bulletin of the European Atomic Energy Community) *(Netherlands)*
Excerpta Med., Sect. XXIII
*Excerpta Medica, Section XXIII *(Netherlands)*
Experientia
*Experientia *(Switzerland)*
Explosivstoffe
Explosivstoffe *(Germany)*
Exptl. Cell Res.
*Experimental Cell Research *(U. S.)*
Exptl. Mech.
Experimental Mechanics *(U. S.)*
Exptl. Med. Surg.
Experimental Medicine and Surgery *(U. S.)*
Exptl. Mol. Pathol.
*Experimental and Molecular Pathology *(U. S.)*

Exptl. Neurol.
Experimental Neurology *(U. S.)*
Exptl. Parasitol.
Experimental Parasitology *(U. S.)*
Exptl. Tech. Physik
*Experimentelle Technik der Physik *(Germany)*
Eye, Ear, Nose Throat Monthly
Eye, Ear, Nose and Throat Monthly, The *(U. S.)*
FAPIG (Tokyo)
FAPIG (Tokyo) *(Japan)*
Farmaco (Pavia) Ed. Prat.
Farmaco, Il (Pavia), Edizione Pratica *(Italy)*
Farmaco (Pavia), Ed. Sci.
Farmaco, Il (Pavia), Edizione Scientifica *(Italy)*
Farmakol. i Toksikol.
Farmakologiya i Toksikologiya† *(U.S.S.R.)*
Farmatsiya (Sofia)
Farmatsiya (Sofia) *(Bulgaria)*
Farm. Polska
Farmacja Polska *(Poland)*
Faserforsch. Textiltech.
Faserforschung und Textiltechnik *(Germany)*
Federation Proc.
*Federation Proceedings *(U. S.)*
Federation Proc., Transl. Suppl.
*Federation Proceedings, Translation Supplement *(U. S.)*
Fermentatio
Fermentatio *(Belgium)*
Fertility Sterility
Fertility and Sterility *(U. S.)*
Figyelo
Figyelo *(Hungary)*
Fijntechniek
Fijntechniek *(Netherlands)*
Finska Lakaresallskapets Handl.
Finska Lakaresallskapets Handlingar *(Finland)*
Fire
Fire *(England)*
Fiz. i Khim. Prirodn. i Sintetich. Polimerov, Akad. Nauk Uz. SSR, Inst. Khim. Polimerov
Fiziki i Khimiya Prirodnykh i Sinteticheskikh Polimerov, Akademiya Nauk Uzbekskoi SSR, Institut Khimii Polimerov *(Uzbek S.S.R.)*
Fiziol. Normala Patol. (Bucharest)
Fiziologia Normala si Patologica (Bucharest) *(Romania)*
Fiziol. Rast.
Fiziologiya Rastenii, Akademiya Nauk SSSR† *(U.S.S.R.)*
Fiziol. Zh., Akad. Nauk Ukr. RSR
*Fiziologichnii Zhurnal, Akademiya Nauk Ukrains'koi RSR *(Ukrainian S.S.R.)*
Fiz. Metal. i Metalloved.
*Fizika Metallov i Metallovedeniya, Akademiya Nauk SSSR, Ural'skii Filial† *(U.S.S.R.)*
Fiz. Plazmy i Probl. Upravlyaemogo Termoyader. Sinteza, Akad. Nauk Ukr. SSR, Fiz.-Tekhn. Inst., Dokl. Vtoroi Konf., Kharkov, 1960
Fizika Plazmy i Problemy Upravlyaemogo Termoyadernogo Sinteza, Akademiya Nauk Ukrainskoi SSR, Fiziko-Tekhnicheskii Institut, Doklady Vtoroi Konferentsii po Fizike Plazmy i Probleme Upravlyaemogo Termoyadernogo Sinteza, Kharkov, November 14-19, 1960 *(Ukrainian S.S.R.)*
Fiz. Probl. Spektroskopii, Akad. Nauk SSSR, Materialy 13-go [Trinadtsatogo] Soveshch. Leningrad, 1960
Fizicheskie Problemy Spektroskopii, Akademiya Nauk SSSR, Materialy 13-go [i. e. Trinadtsatogo] Soveshchaniya, Leningrad, July 4-12, 1960, 1(Pub. 1962) *(U.S.S.R.)*
Fiz. Szemle
*Fizikai Szemle *(Hungary)*
Fiz. Tverd. Tela
Fizika Tverdogo Tela† *(U.S.S.R.)*
Folia Biol. (Prague)
*Folia Biologica (Prague) *(Czechoslovakia)*
Folia Biol. (Warsaw)
*Folia Biologica (Warsaw) *(Poland)*
Folia Clin. Intern.
*Folia Clinica Internacional *(Spain)*
Folia Endocrinol. (Rome)
Folia Endocrinologica (Rome) *(Italy)*
Folia Haematol. (Frankfurt)
*Folia Haematologica (Frankfurt) *(Germany)*
Folia Med. (Naples)
*Folia Medica (Naples) *(Italy)*
Folia Microbiol. (Prague)
Folia Microbiologica (Prague) *(Czechoslovakia)*
Folia Morphol.
*Folia Morphologica *(Poland)*
Food Eng.
Food Engineering *(U. S.)*
Food Irradiation
*Food Irradiation *(France)*
Food Process.
Food Processing *(U. S.)*
Food Technol.
Food Technology *(U. S.)*
Forest Prod. J.
Forest Products Journal *(U. S.)*
Forsch. Gebiete Ingenieurw.
Forschung auf dem Gebiete des Ingenieurwesens *(Germany)*
Fortschr. Chem. Forsch.
*Fortschritte der Chemischen Forschung *(Germany)*
Fortschr. Gebiete Roentgenstrahlen Nuklearmed.
*Fortschritte auf dem Gebiete der Roentgenstrahlen und der Nuklearmedizin, Diagnostik, Physik, Biologie, Therapie *(Germany)*
Fortschr. Physik
*Fortschritte der Physik *(Germany)*
Frankfurter Z. Pathol.
Frankfurter Zeitschrift fuer Pathologie *(Germany)*
Freiberger Forschungsh. B
Freiberger Forschungshefte. Reihe B *(Germany)*
Fuel
Fuel *(England)*
Fuji Elec. J.
Fuji Electric Journal
see Fuji Jiho
Fuji Jiho
Fuji Jiho (Fuji Electric Journal) *(Japan)*
Fukuoka Acta Med.
Fukuoka Acta Medica
see Fukuoka Igaku Zasshi
Fukuoka Igaku Zasshi
Fukuoka Igaku Zasshi (Fukuoka Acta Medica) *(Japan)*
Funtai Oyobi Funmatsuyakin
Funtai Oyobi Funmatsuyakin (Journal of Japan Society of Powder Metallurgy) *(Japan)*
Gac. Med. Caracas
Gaceta Medica de Caracas *(Venezuela)*
Gac. Med. Mex.
Gaceta Medica de Mexico *(Mexico)*
Gac. Ortoped. Traumatol.
*Gaceta Ortopedia y Traumatologia *(Mexico)*
Gastroenterology
Gastroenterology *(U. S.)*
Gas-Wasserfach
Gas-Wasserfach, Das *(Germany)*
Gaz. Med. France
Gazette Medicale de France *(France)*
Gazz. Chim. Ital.
Gazzette Chimica Italiana *(Italy)*
Gazz. Osp. Clin.
Gazzetta degli Ospedali e delle Cliniche *(Italy)*
Geburtsh Frauenheilk.
*Geburtshilfe und Frauenheilkunde *(Germany)*
G.E.C.J. Sci. Tech.
*G. E. C. Journal of Science and Technology *(England)*
G.E.N. (Caracas)
*G.E.N. (Caracas) *(Venezuela)*
Gencho Hiroshima Igaku
*Gencho Hiroshima Igaku (The Hiroshima Medical Journal) *(Japan)*
Gen. Comp. Endocrinol.
*General and Comparative Endocrinology *(U. S.)*
Genet. Agrar.
Genetica Agraria *(Italy)*
Genet. Iberica
Genetica Iberica *(Spain)*
Genetica
*Genetica *(Netherlands)*
Genetics
*Genetics *(U. S.)*

Genet. Polon.
*Genetica Polonica *(Poland)*
Genet. Res.
*Genetical Research *(England)*
Genie Chim.
Genie Chimique (Supplement mensuel a Chimie & Industrie) *(France)*
Genshikaku Kenkyu
Genshikaku Kenkyu *(Japan)*
Genshiryoku Hatsuden
*Genshiryoku Hatsuden (Nuclear Power) *(Japan)*
Genshiryoku Kogyo
*Genshiryoku Kogyo (Nuclear Engineering) *(Japan)*
Geochemistry (USSR) (English Transl.)
Geochemistry (USSR) (English Translation of Geokhimiya) *(U. S.)*
Geochim. Cosmochim. Acta
*Geochimica et Cosmochimica Acta *(England)*
Geofis. Pura Appl.
Geofisica Pura e Applicata *(Italy)*
Geokhimiya
*Geokhimiya† *(U.S.S.R.)*
Geol. Foren. Stockholm Forh.
Geologiska Foreningens i Stockholm Forhandlingar *(Sweden)*
Geol. Surv. Korea, Tech. Paper
Geological Survey of Korea, Technical Paper *(Korea)*
Geomagnetism Aeronomy (USSR) (English Transl.)
*Geomagnetism and Aeronomy (USSR) (English Translation of Geomagnetizm i Aeronomiya) *(U. S.)*
Geomagnetizm i Aeronomiya
Geomagnetizm i Aeronomiya† *(U.S.S.R.)*
Geophysics
*Geophysics *(U. S.)*
Geophys. J.
Geophysical Journal *(England)*
Geophys. Mag. (Tokyo)
Geophysical Magazine (Tokyo) *(Japan)*
Geotecnica
Geotecnica *(Italy)*
Geriatrics
Geriatrics *(U. S.)*
Gerontol. Clin.
*Gerontologia Clinica *(Switzerland)*
Gerontologia
*Gerontologia *(Switzerland)*
Gidrotekhn. i Melioratskiya
Gidrotekhnika i Melioratsiya *(U.S.S.R.)*
Gigiena i Sanit.
*Gigiena i Sanitariya *(U. S. S. R.)*
Gigiena Truda i Prof. Zabolevaniya
Gigiena Truda i Professional'nye Zabolevaniya *(U.S.S.R.)*
Ginecol. Obstet. Mex.
*Ginecologia y Obstetricia de Mexico *(Mexico)*
Ginekol. Polska
Ginekologia Polska *(Poland)*
Giorn. Gerontol.
*Giornale di Gerontologia *(Italy)*
Giorn. Igiene Med. Prevent.
Giornale di Igiene e Medicina Preventiva *(Italy)*
Giorn. Ital. Chemioterapia
*Giornale Italiano di Chemioterapia *(Italy)*
Giorn. Ital. Dermatol.
Giornale Italiano di Dermatologia *(Italy)*
Giorn. Ital. Patol. Sci. Affini
Giornale Italiano di Patologia e di Scienze Affini *(Italy)*
Giorn. Med. Militare
Giornale di Medicina Militare *(Italy)*
Giorn. Microbiol.
*Gironale di Microbiologia *(Italy)*
Gisto-Gematicheskie Bar'ery i Ioniziruyushchaya Radiatsiya, Akad. Nauk SSSR, Inst. Biol. Fiz., Sb. Rabot
Gisto-Gematicheskie Bar'ery i Ioniziruyushchaya Radiatsiya, Akademiya Nauk SSSR, Institut Biologicheskoi Fiziki, Sbornik Rabot *(U.S.S.R.)*
Glasnik Mat.-Fiz. Astron., Ser. II
*Glasnik Matematicko-Fizicki i Astronomski, Serija II *(Yugoslavia)*
Glueckauf
Glueckauf *(Germany)*
Gruzlica Choroby Pluc
Gruzlica Choroby Pluc *(Poland)*
Gunma J. Med. Sci.
*Gunma Journal of Medical Sciences, The *(Japan)*
Gut
Gut *(England)*
Guy's Hosp. Rept.
*Guy's Hospital Reports *(England)*
Gynaecologia
Gynaecologia *(Switzerland)*
Harper Hosp. Bull.
Harper Hospital Bulletin *(U. S.)*
Hautarzt
Hautarzt, Der *(Austria)*
Health Phys.
*Health Physics *(U. S.-England)*
Heating Ventilating Engr.
Heating and Ventilating Engineer and Journal of Air Conditioning *(England)*
Heidelberger Beitr. Mineral. Petrog.
Heidelberger Beitraege zur Mineralogie und Petrographie *(Germany)*
Helv. Chim. Acta
*Helvetica Chimica Acta *(Switzerland)*
Helv. Chir. Acta
*Helvetica Chirurgica Acta *(Switzerland)*
Helv. Med. Acta
*Helvetica Medica Acta *(Switzerland)*
Helv. Paediat. Acta
*Helvetica Paediatrica Acta *(Switzerland)*
Helv. Phys. Acta
*Helvetica Physica Acta *(Switzerland)*
Helv. Physiol. Pharmacol. Acta
Helvetica Physiologica et Pharmacologica Acta *(Switzerland)*
Hemostase
Hemostase *(France)*
Hereditas
*Hereditas *(Sweden)*
Heredity
Heredity *(England)*
High Temp. (USSR) (English Transl.)
*High Temperature (USSR) (English Translation of Teplofiziko Vysokikh Temperatur) *(U. S.)*
Hi-hakai Kensa
Hi-hakai Kensa (Journal of N.D.I.) *(Japan)*
Hindustan Antibiot. Bull.
*Hindustan Antibiotics Bulletin *(India)*
Hippokrates (Stuttgart)
Hippokrates (Stuttgart) *(Germany)*
Hirosaki Igaku
*Hirosaki Igaku (The Hirosaki Medical Journal) *(Japan)*
Hirosaki Med. J.
Hirosaki Medical Journal, The
see Hirosaki Igaku
Hiroshima Igaku
Hiroshima Igaku (The Journal of the Hiroshima Medical Association) *(Japan)*
Hiroshima J. Med. Sci.
*Hiroshima Journal of Medical Sciences *(Japan)*
Hiroshima Med. J.
Hiroshima Medical Journal, The
see Gencho Hiroshima Igaku
Hitachi Hyoron
Hitachi Hyoron (Hitachi Review) *(Japan)*
Hitachi Rev.
Hitachi Review
see Hitachi Hyoron
Hitachi Zosen Giho
Hitachi Zosen Giho (The Hitachi Zosen Technical Review) *(Japan)*
Hitachi Zosen Tech. Rev.
Hitachi Zosen Technical Review, The
see Hitachi Zosen Giho
Hokkaido Igaku Zasshi
Hokkaido Igaku Zasshi (The Hokkaido Journal of Medical Science) *(Japan)*
Hokkaido J. Med. Sci.
Hokkaido Journal of Medical Science, The
see Hokkaido Igaku Zasshi
Holzforschung
Holzforschung *(Germany)*
Horticultura
Horticultura *(Denmark)*

Hoshasen Kobunshi
*Hoshasen Kobunshi (Radiation Research on Polymers) *(Japan)*
Hospital (Rio de Janeiro)
Hospital, O (Rio de Janeiro) *(Brazil)*
Hospitals
Hospitals *(U. S.)*
Hosp. Management
Hospital Management *(U. S.)*
Hosp. Progr.
Hospital Progress *(U. S.)*
Ho Tsu K'o Hsueh
*Ho Tsu K'o Hsueh (Nuclear Science) *(China)*
Hua Hsueh Hsueh Pao
Hua Hsueh Hsueh Pao (Acta Chimica Sinica) *(China)*
Hua Hseuh Tung Pao
*Hua Hseuh Tung Pao (Chemical Bulletin) *(China)*
Huaxue Tongbao
Huaxue Tongbao
see Hua Hseuh Tung Pao
Hutnicke Listy
Hutnicke Listy *(Czechoslovakia)*
Hydrocarbon Process. Petrol. Refiner
Hydrocarbon Processing and Petroleum Refiner *(U. S.)*
IBM J. Res. Develop.
IBM Journal of Research and Development *(U. S.)*
I.C.R.S. Med. Rept.
*I.C.R.S. (Institute of Contemporary Russian Studies) Medical Reports *(U. S.)*
ICSU (Intern. Council Sci. Unions) Rev. World Sci.
ICSU (International Council of Scientific Unions) Review of World Science *(Netherlands)*
Idengaku Zasshi
*Idengaku Zasshi (Japanese Journal of Genetics) *(Japan)*
Idojaras
Idojaras *(Hungary)*
IEEE (Inst. Elec. Electron. Engrs.), Spectrum
*IEEE (Institute of Electrical and Electronics Engineers), Spectrum *(U. S.)*
IEEE (Inst. Elec. Electron. Engrs.), Trans. Appl. Ind.
*IEEE (Institute of Electrical and Electronics Engineers), Transactions on Applications and Industry *(U. S.)*
IEEE (Inst. Elec. Electron. Engrs.), Trans. Commun. Electron.
*IEEE (Institute of Electrical and Electronics Engineers), Transactions on Communication and Electronics *(U. S.)*
IEEE (Inst. Elec. Electron. Engrs.) Trans. Electron. Computers
IEEE (Institute of Electrical and Electronics Engineers), Transactions on Electronic Computers (formerly IRE (Institute of Radio Engineers), Transactions on Electronic Computers) *(U. S.)*
IEEE (Inst. Elec. Electron. Engrs.), Trans. Electron Devices
IEEE (Institute of Electrical and Electronics Engineers), Transactions on Electron Devices (formerly IRE (Institute of Radio Engineers), Transactions on Electron Devices) *(U. S.)*
IEEE (Inst. Elec. Electron. Engrs.), Trans. Instr. Meas.
IEEE (Institute of Electrical and Electronics Engineers), Transactions on Instrumentation and Measurement (formerly IRE (Institute of Radio Engineers), Transactions on Instrumentation) *(U. S.)*
IEEE (Inst. Elec. Electron. Engrs.), Trans. Microwave Theory Tech.
IEEE (Institute of Electrical and Electronics Engineers), Transactions on Microwave Theory and Techniques (formerly IRE (Institute of Radio Engineers), Transactions on Microwave Theory and Techniques) *(U. S.)*
IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci.
*IEEE (Institute of Electrical and Electronics Engineers), Transactions on Nuclear Science (formerly IRE (Institute of Radio Engineers), Transactions on Nuclear Science) *(U. S.)*
IEEE (Inst. Elec. Electron. Engrs.), Trans. Power App. Systems
*IEEE (Institute of Electrical and Electronics Engineers), Transactions on Power Apparatus and Systems *(U. S.)*
Igaku To Seibutsugaku
Igaku To Seibutsugaku (Medicine and Biology) *(Japan)*
Igiene Mod. (Parma)
Igiene Moderna, L'(Parma) *(Italy)*
Igiene Sanita Pubblica (Rome)
Igiene e Sanita Pubblica (Rome) *(Italy)*
Ikushugaku Zasshi
Ikushugaku Zasshi (Japanese Journal of Breeding) *(Japan)*
Immunology
*Immunology *(England)*
Ind. At.
*Industries Atomiques *(France)*
Ind. Chemist
Industrial Chemist and Chemical Manufacturer, The *(England)*
Ind. Chim. Belge
*Industrie Chimique Belge *(Belgium)*
Ind. Diamond Rev.
Industrial Diamond Review *(England)*
Ind. Electron.
Industrial Electronics incorporating Electronic Technology *(England)*
Ind. Eng. Chem.
*Industrial and Engineering Chemistry *(U. S.)*
Ind. Eng. Chem., Fundamentals
*Industrial & Engineering Chemistry, Fundamentals *(U. S.)*
Ind. Eng. Chem., Process Design Develop.
*Industrial & Engineering Chemistry, Process Design and Development *(U. S.)*
Ind. Eng. Chem., Prod. Res. Develop.
*Industrial & Engineering Chemistry, Product Research and Development *(U. S.)*
Indian Eastern Engr.
*Indian & Eastern Engineer, The (incorporating the Far Eastern Engineer and Indian & Eastern Motors) *(India)*
Indian Inst. Technol. (Delhi), Phys. Bull.
Indian Institute of Technology (Delhi), Physics Bulletin *(India)*
Indian J. Chem.
*Indian Journal of Chemistry *(India)*
Indian J. Child Health
*Indian Journal of Child Health, The *(India)*
Indian J. Exptl. Biol.
*Indian Journal of Experimental Biology *(India)*
Indian J. Genet. Plant Breeding
Indian Journal of Genetics & Plant Breeding *(India)*
Indian J. Med. Res.
Indian Journal of Medical Research, The *(India)*
Indian J. Med. Sci.
*Indian Journal of Medical Sciences *(India)*
Indian J. Meteorol. Geophys.
Indian Journal of Meteorology & Geophysics *(India)*
Indian J. Phys.
*Indian Journal of Physics and Proceedings of the Indian Association for the Cultivation of Science *(India)*
Indian J. Pure Appl. Phys.
*Indian Journal of Pure & Applied Physics *(India)*
Indian J. Radiol.
*Indian Journal of Radiology *(India)*
Indian J. Technol.
*Indian Journal of Technology (formerly Journal of Scientific and Industrial Research (India), Section D) *(India)*
Indian J. Theoret. Phys.
Indian Journal of Theoretical Physics *(India)*
Indian Minerals
*Indian Minerals *(India)*
Ind. Ital. Cemento
Industria Italiana del Cemento, L' *(Italy)*
Ind. Med. Surg.
Industrial Medicine and Surgery *(U. S.)*
Ind. Plastiques Mod. (Paris)
Industrie des Plastiques Modernes (Paris) *(France)*
Ind. Quality Control
Industrial Quality Control *(U. S.)*
Ind. Res.
*Industrial Research *(U. S.)*
Ind. Rev. Africa. Suppl. At. Energy
*Industrial Review of Africa. Supplement. Atomics and Energy *(Union of S. Africa)*
Inform. Sb., Vses. Nauchn.-Issled. Geol. Inst.
Informatsionnyi Sbornik, Vsesoyuznyi Nauchno-Issledovatel'skii Geologicheskii Institut *(U.S.S.R.)*
Infrared Phys.
*Infrared Physics *(U. S.—England)*
Ingenieur (Utrecht)
Ingenieur, De (Utrecht) *(Netherlands)*
Ingenioeren
*Ingenioeren *(Denmark)*
Ing. Sanit.
Ingeneria Sanitaria *(Mexico)*
Inorg. Chem.
*Inorganic Chemistry *(U. S.)*

Inst. Engrs., Australia. Elec. Mech. Eng. Trans.
Institution of Engineers, Australia. Electrical and Mechanical Engineering Transactions *(Australia)*

Instr. Control Systems
Instruments and Control Systems *(U. S.)*

Instr. Nucl. (Paris)
*Instrumentation Nucleaire (Paris). Supplement au Bulletin d'Informations Scientifiques et Techniques (Paris) *(France)*

Inst. Sewage Purif., J. Proc.
Institute of Sewage Purification, The, Journal and Proceedings *(England)*

Insulation (Libertyville)
Insulation (Libertyville) *(U. S.)*

Intern. Arch. Allergy Appl. Immunol.
*International Archives of Allergy and Applied Immunology *(Switzerland)*

Intern. Arch. Gewerbepathol. Gewerbehyg.
Internationales Archiv fuer Gewerbepathologie und Gewerbehygiene *(Germany)*

Intern. At. Energy Agency Bull.
*International Atomic Energy Agency Bulletin *(Austria)*

Intern. Chem. Eng.
*International Chemical Engineering *(U. S.)*

Internist
Internist, Der *(Germany)*

Intern. J. Air Water Pollution
*International Journal of Air & Water Pollution (formerly International Journal of Air Pollution) *(England)*

Intern. J. Appl. Radiation Isotopes
*International Journal of Applied Radiation and Isotopes *(England)*

Intern. J. Heat Mass Transfer
*International Journal of Heat and Mass Transfer *(England)*

Intern. J. Neurol.
International Journal of Neurology *(Uruguay)*

Intern. J. Radiation Biol.
*International Journal of Radiation Biology and related studies in Physics, Chemistry and Medicine *(England)*

Intern. Rev. Exptl. Pathol.
International Review of Experimental Pathology *(England)*

Intern. Sci. Technol.
*International Science and Technology *(U. S.)*

Intern. Shipbuilding Progr.
International Shipbuilding Progress *(Netherlands)*

Intern. Z. Vitaminforsch.
Internationale Zeitschrift fuer Vitaminforschung *(Switzerland)*

Invest. Ophthalmol.
Investigative Ophthalmology *(U. S.)*

Inzh.-Fiz. Zh., Akad. Nauk Belorussk. SSR
*Inzhenerno-Fizicheskii Zhurnal, Akademii Nauk Belorusskoi SSR *(U.S.S.R.)*

IRE (Inst. Radio Engrs.), Trans. Bio-Med. Electron.
IRE (Institute of Radio Engineers), Transactions on Bio-Medical Electronics *(U. S.)*

Irish J. Med. Sci.
Irish Journal of Medical Science, The *(Ireland)*

Iron Age
Iron Age *(U. S.)*

Iryo (Tokyo)
Iryo (Tokyo) (Medical Treatment) *(Japan)*

ISA (Instr. Soc. Am.) Trans.
*ISA (Instrument Society of America) Transactions *(U. S.)*

Ishikawajima-Harima Eng. Rev.
Ishikawajima-Harima Engineering Review
see Ishikawajima-Harima Giho

Ishikawajima-Harima Giho
Ishikawajima-Harima Giho (Ishikawajima-Harima Engineering Review) *(Japan)*

Iskusstv. Sputniki Zemli, Akad. Nauk SSSR
Iskusstvennye Sputniki Zemli, Akademiya Nauk SSSR *(U.S.S.R.)*

Isotopen Tech.
Isotopen Technik *(Germany)*

Isotopes Radiation Technol.
*Isotopes and Radiation Technology (A Quarterly Technical Progress Review) *(U. S.)*

Israel J. Botany
*Israel Journal of Botany (formerly Bulletin of the Research Council of Israel, Section D) *(Israel)*

Israel J. Chem.
*Israel Journal of Chemistry (supersedes Bulletin of the Research Council of Israel, Section A: Chemistry) *(Israel)*

Israel J. Earth-Sci.
*Israel Journal of Earth-Sciences (formerly Bulletin of the Research Council of Israel, Section G) *(Israel)*

Israel J. Exptl. Med.
*Israel Journal of Experimental Medicine (formerly Bulletin of the Research Council of Israel, Section E) *(Israel)*

Israel J. Phys.
*Israel Journal of Physics (supersedes in part Bulletin of the Research Council of Israel, Section F: Mathematics and Physics) *(Israel)*

Israel J. Technol.
*Israel Journal of Technology (supersedes Bulletin of the Research Council of Israel, Section C) *(Israel)*

Israel J. Zool.
*Israel Journal of Zoology (formerly Bulletin of the Research Council of Israel, Section B) *(Israel)*

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Issledovaniya po Vysokoprochnym Splavam i Nitevidnym Kristallam, Akademiya Nauk SSSR, Institut Metallurgii im. A. A. Baikova, Doklady na Nauchnoi Sessii, 1962 (Pub. 1963) *(U.S.S.R.)*

Issled. po Zharoprock. Splavam, Akad. Nauk SSSR, Inst. Met.
*Issledovaniya po Zharoprochnym Splavam, Akademiya Nauk SSSR, Institut Metallurgii imeni A. A. Baikova *(U.S.S.R.)*

Issled. Splavov Tsvetn. Metal. Akad. Nauk SSSR, Inst. Met.
Issledovanie Splavov Tsvetnykh Metallov, Akademiya Nauk SSSR, Institut Metallurgii imeni A. A. Baikova *(U.S.S.R.)*

Issled. v Obl. Khim. Urana, Sb. Statei
Issledovaniya v Oblasti Khimii Urana, Sbornik Statei *(U.S.S.R.)*

Istanbul Tek. Univ. Bul.
Istanbul Teknik Universitesi Bulteni *(Turkey)*

Istanbul Univ., Fen Fak. Mecmuasi, Seri C
*Istanbul Universitesi Fen Fakultesi Mecmuasi: Seri C: Astronomi-Fizik-Kimya *(Turkey)*

Ital. J. Biochem.
*Italian Journal of Biochemistry (English edition of Giornale de biochimica) *(Italy)*

Izmeritel. Tekhn.
*Izmeritel'naya Tekhnika' *(U.S.S.R.)*

Izv. Akad. Nauk Arm. SSR, Biol. Nauki
Izvestiya Akademii Nauk Armyanskoi SSR, Biologicheskie Nauki *(Armenian S.S.R.)*

Izv. Akad. Nauk Arm. SSR, Nauk Zemle
*Izvestiya Akademii Nauk Armyanskoi SSR, Nauk o Zemle *(Armenian S.S.R.)*

Izv. Akad. Nauk Arm. SSR, Ser. Fiz. Mat. Nauk
*Izvestiya Akademii Nauk Armyanskoi SSR, Seriya Fiziko-Matematicheskikh Nauk *(Armenian S.S.R.)*

Izv. Akad. Nauk Azerb. SSR, Ser. Biol. i Med. Nauk
Izvestiya Akademii Nauk Azerbaidzhanskoi SSR, Seriya Biologicheskikh i Meditsinskikh Nauk *(Azerbaidzhan S.S.R.)*

Izv. Akad. Nauk Azerb. SSR, Ser. Fiz. Mat. i Tekhn. Nauk
*Izvestiya Akademii Nauk Azerbaidzhanskoi SSR, Seriya Fiziko-Matematicheskikh i Tekhnicheskikh Nauk (formerly Izvestiya Akademii Nauk Azerbaidzhanskoi SSR, Seriya Fiziko Tekhnicheskikh i Khimicheskikh Nauk) *(Azerbaidzhan S.S.R.)*

Izv. Akad. Nauk Est. SSR, Ser. Biol.
*Izvestiya Akademii Nauk Estonskoi SSR, Seriya Biologicheskaya *(Estonian S.S.R.)*

Izv. Akad. Nauk Est. SSR, Ser. Fiz. Mat. i Tekhn. Nauk
*Izvestiya Akademii Nauk Estonskoi SSR, Seriya Fiziko-Matematicheskikh i Tekhnicheskikh Nauk (formerly Izvestiya Akademii Nauk Estonskoi SSR, Seriya Tekhnicheskikh i Fiziko Matematicheskikh Nauk) *(Estonian S.S.R.)*

Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat. Nauk
*Izvestiya Akademii Nauk Kazakhskoi SSR, Seriya Fiziko-Matematicheskikh Nauk *(Kazakh S.S.R.)*

Izv. Akad. Nauk Kaz. SSR, Ser. Tekhn. i Khim. Nauk
Izvestiya Akademii Nauk Kazakhskoi SSR, Seriya Tekhnicheskikh i Khimicheskikh Nauk (supersedes in part Izvestiya Akademii Nauk Kazakhskoi SSR, Seriya Khimicheskaya) *(Kazakh S.S.R.)*

Izv. Akad. Nauk SSSR, Energ. i Transp.
*Izvestiya Akademii Nauk SSSR, Energetika i Transport (formerly Izvestiya Akademii Nauk SSSR, Otdelenie Tekhnicheskikh Nauk, Energetika i Transport) *(U.S.S.R.)*

Izv. Akad. Nauk SSSR, Mekhan. i Mashinostr.
*Izvestiya Akademii Nauk SSSR, Mekhanika i Mashinostroenie (formerly Izvestiya Akademii Nauk SSSR, Otdelenie Tekhnicheskikh Nauk, Mekhanika i Mashinostroenie) *(U.S.S.R.)*

Izv. Akad. Nauk SSSR, Met. i Gorn. Delo
*Izvestiya Akademii Nauk SSSR, Metallurgiya i Gornoe Delo (formerly Izvestiya Akademii Nauk SSSR, Otdelenie Tekhnicheskikh Nauk, Metallurgiya i Gornoe Delo) *(U.S.S.R.)*

Izv. Akad. Nauk SSSR, Otd. Tekhn. Nauk, Mekhan. i Mashinostr.
Izvestiya Akademii Nauk SSSR, Otdelenie Tekhnicheskikh Nauk, Mekhanika i Mashinostroenie (formerly included with two other parts in Izvestiya Akademii Nauk SSSR, Otdelenie Tekhnicheskikh Nauk) *(U.S.S.R.)*

Izv. Akad. Nauk SSSR, Otd. Tekhn. Nauk, Met. i Gorn. Delo
Izvestiya Akademii Nauk SSSR, Otdelenie Tekhnicheskikh Nauk, Metalluraiya i Gornoe Delo (formerly Izvestiya Akademii Nauk SSSR, Otdelenie Tekhnicheskikh Nauk, Metalluraiya i Toplivo) *(U.S.S.R.)*

Izv. Akad. Nauk SSSR, Otd. Tekhn. Nauk, Met. i Toplivo
Izvestiya Akademii Nauk SSSR, Otdelenie Tekhnicheskikh Nauk, Metalluraiya i Toplivo† (formerly included with two other parts in Izvestiya Akademii Nauk SSSR, Otdelenie Tekhnicheskikh Nauk) *(U.S.S.R.)*

Izv. Akad. Nauk SSSR, Ser. Biol.
*Izvestiya Akademii Nauk SSSR, Seriya Biologicheskaya *(U.S.S.R.)*

Izv. Akad. Nauk SSSR, Ser. Fiz.
*Izvestiya Akademii Nauk SSSR, Seriya Fizicheskaya† *(U.S.S.R.)*

Izv. Akad. Nauk SSSR, Ser. Geofiz.
*Izvestiya Akademii Nauk SSSR, Seriya Geofizicheskaya† *(U.S.S.R.)*

Izv. Akad. Nauk SSSR, Ser. Khim.
*Izvestiya Akademii Nauk SSSR, Seriya Khimicheskaya (formerly Izvestiya Akademii Nauk SSSR, Otdelenie Khimicheskikh Nauk) *(U.S.S.R.)*

Izv. Akad. Nauk SSSR, Tekhn. Kibernetika
*Izvestiya Akademii Nauk SSSR, Tekhnicheskaya Kibernetika (formerly Izvestiya Akademii Nauk SSSR, Otdelenie Tekhnicheskikh Nauk, Tekhnicheskaya Kibernetika) *(U.S.S.R.)*

Izv. Akad. Nauk Uz. SSR, Ser. Fiz.-Mat. Nauk
*Izvestiya Akademii Nauk Uzbekskoi SSR, Seriya Fiziko-Matematicheskikh Nauk *(Uzbek S.S.R.)*

Izv. Fiz. Inst. s Aneb, Bulgar. Akad. Nauk.
Izvestiya na Fizicheskiya Institut s Aneb, Bulgarska Akademiya na Naukite *(Bulgaria)*

Izv. Krymsk. Astrofiz. Observ.
Izvestiya Krymskoi Astrofizicheskoi Observatorii *(U.S.S.R.)*

Izv. Sibirsk. Otd. Akad. Nauk SSSR
*Izvestiya Sibirskogo Otdeleniya Akademii Nauk SSSR *(U.S.S.R.)*

Izv. Sibirsk. Otd. Akad. Nauk SSSR, Ser. Biol.-Med. Nauk
Izvestiya Sibirskogo Otdeleniya Akademii Nauk SSSR, Seriya Biologo-Meditsinskikh Nauk *(U.S.S.R.)*

Izv. Sibirsk. Otd. Akad. Nauk SSSR, Ser. Khim. Nauk
*Izvestiya Sibirskogo Otdeleniya Akademii Nauk SSSR, Seriya Khimicheskikh Nauk *(U.S.S.R.)*

Izv. Sibirsk. Otd. Akad. Nauk SSSR, Ser. Tekhn. Nauk.
*Izvestiya Sibirskogo Otdeleniya Akademii Nauk SSSR, Seriya Tekhnicheskikh Nauk (supersedes in part Izvestiya Sibirskogo Otdeleniya Akademii Nauk SSSR) *(U.S.S.R.)*

Izv. Timiryazev. Sel'skokhoz. Akad.
Izvestiya Timiryazevskoi Sel'skokhozyaistvennoi Akademii *(U.S.S.R.)*

Izv. Vysshikh Uchebn. Zavedenii, Aviats. Tekhn.
Izvestiya Vysshikh Uchebnykh Zavedenii, Aviatsionnaya Tekhnika *(U.S.S.R.)*

Izv. Vysshikh Uchebn. Zavedenii, Chernaya Met.
Izvestiya Vysshikh Uchebnykh Zavedenii, Chernaya Metalluraiya *(U.S.S.R.)*

Izv. Vysshikh Uchebn. Zavedenii, Fiz.
*Izvestiya Vysshikh Uchebnykh Zavedenii, Fizika *(U.S.S.R.)*

Izv. Vysshikh Uchebn. Zavedenii, Geod. i Aerofotos'emka
Izvestiya Vysshykh Uchebnykh Zavedenii, Geodeziya i Aerofotos'emka *(U.S.S.R.)*

Izv. Vysshikh Uchebn. Zavedenii, Geol. i Razvedka
Izvestiya Vysshikh Uchebnykh Zavedenii, Geologiya i Razvedka *(U.S.S.R.)*

Izv. Vysshikh Uchebn. Zavedenii, Khim. i Khim. Tekhnol.
Izvestiya Vysshikh Uchebnykh Zavedenii, Khimiya i Khimicheskaya Tekhnologiya *(U.S.S.R.)*

Izv. Vysshikh Uchebn. Zavedenii, Mat.
*Izvestiya Vysshikh Uchebnykh Zavedenii, Matematika *(U.S.S.R.)*

Izv. Vysshikh Uchebn. Zavedenii, Pishchevaya Tekhnol.
Izvestiya Vysshikh Uchebnykh Zavedenii, Pishchevaya Tekhnologiya *(U.S.S.R.)*

Izv. Vysshikh Uchebn. Zavedenii, Radiofiz.
*Izvestiya Vysshikh Uchebnykh Zavednii, Radiofizika† *(U.S.S.R.)*

Izv. Vysshikh Uchebn. Zavedenii, Tsvetn. Met.
*Izvestiya Vysshikh Uchebnykh Zavednii, Tsvetnaya Metalluraiya *(U.S.S.R.)*

Jaarb. Kankeronderz. Ned.
Jaarboek van Kankeronderzoek en Kankerbestrijding in Nederland *(Netherlands)*

Jaderna Energie
*Jaderna Energie *(Czechoslovakia)*

J. Aerospace Sci.
Journal of the Aerospace Sciences *(U. S.)*

J. Agr. Assoc. China (Taipei)
Journal of the Aaricultural Association of China (Taipei) *(China)*

J. Agr. Chem. Soc. Japan
Journal of the Aaricultural Chemical Society of Japan
see Nippon Nogeikagaku Kaishi

J. Agr. Food Chem.
Journal of Aaricultural and Food Chemistry *(U. S.)*

J. Agr. Sci.
Journal of Aaricultural Science, The *(England)*

Jahrb. Akad. Wiss. Goettingen
*Jahrbuch der Akademie der Wissenschaften in Goettingen *(Germany)*

Jahresber. Deut. Wetterdienstes
*Jahresberichte des Deutschen Wetterdienstes *(Germany)*

J. Albert Einstein Med. Center
Journal of the Albert Einstein Medical Center *(U. S.)*

J. Am. Ceram. Soc.
*Journal of the American Ceramic Society *(U. S.)*

J. Am. Chem. Soc.
*Journal of the American Chemical Society *(U. S.)*

J. Am. Dental Assoc.
Journal of the American Dental Association, The *(U. S.)*

J. Am. Dietet. Assoc.
Journal of the American Dietetic Association *(U. S.)*

J. Am. Med. Assoc.
Journal of the American Medical Association, The *(U. S.)*

J. Am. Med. Women's Assoc.
Journal of the American Medical Women's Association *(U. S.)*

J. Am. Oil Chemists' Soc.
Journal of the American Oil Chemists' Society, The *(U. S.)*

J. Am. Osteophath. Assoc.
Journal of the American Osteopathic Association, The *(U. S.)*

J. Am. Podiat. Assoc.
Journal of the American Podiatry Association *(U. S.)*

J. Am. Soc. Naval Engrs.
Journal of the American Society of Naval Engineers, Inc. *(U. S.)*

J. Am. Water Works Assoc.
*Journal of the American Water Works Association *(U. S.)*

J. Animal Sci.
Journal of Animal Science *(U. S.)*

Japan Analyst
Japan Analyst
see Bunseki Kagaku

Japan. Circulation J. (English Ed.)
*Japanese Circulation Journal (English Edition) *(Japan)*

Japan. Heart J.
*Japanese Heart Journal *(Japan)*

Japan. J. Appl. Phys.
*Japanese Journal of Applied Physics *(Japan)*

Japan. J. Breeding
Japanese Journal of Breeding
see Ikushugaku Zasshi

Japan. J. Genetics
Japanese Journal of Genetics
see Idengaku Zasshi

Japan. J. Hyg.
Japanese Journal of Hygiene
see Nippon Eiseigaku Zasshi

Japan. J. Ind. Health
Japanese Journal of Industrial Health
see Sangyo Igaku

Japan. J. Med. Progr.
Japanese Journal of Medical Progress
see Nisshin Igaku

Japan J. Microbiol.
Japanese Journal of Microbiology *(Japan)*

Japan. Med. J.
Japanese Medical Journal
see Nippon Iji Shimpo

J. Appl. Bacteriol.
Journal of Applied Bacteriology, The *(England)*

J. Appl. Chem. (London)
*Journal of Applied Chemistry (London) *(England)*

J. Appl. Mech.
*Journal of Applied Mechanics, Transactions of the ASME, Series E *(U. S.)*

J. Appl. Meteorol.
*Journal of Applied Meteorology *(U. S.)*

J. Appl. Nutr.
Journal of Applied Nutrition, The *(U. S.)*

J. Appl. Phys.
*Journal of Applied Physics *(U. S.)*

J. Appl. Phys. (Japan)
Journal of Applied Physics (Japan)
see Oyo Butsuri

J. Appl. Physiol.
*Journal of Applied Physiology *(U. S.)*

J. Appl. Polymer Sci.
*Journal of Applied Polymer Science *(U. S.)*

J. Arkansas Med. Soc.
Journal of the Arkansas Medical Society, The *(U. S.)*

J. Assoc. Offic. Agr. Chemists
*Journal of the Association of Official Agricultural Chemists *(U. S.)*

J. Assoc. Physicians India
Journal of the Association of the Physicians of India *(India)*

J. At. Energ. Soc. Japan
Journal of the Atomic Energy Society of Japan
see Nippon Genshiryoku Gakkaishi

J. Atmospheric Sci.
*Journal of the Atmospheric Sciences (formerly the Journal of Meteorology) *(U. S.)*

J. Atmospheric Terrest. Phys.
*Journal of Atmospheric and Terrestrial Physics *(U. S.)*

J. Australian Inst. Metals
*Journal of the Australian Institute of Metals *(Australia)*

J. Bacteriol.
*Journal of Bacteriology *(U. S.)*

J. Basic Eng.
*Journal of Basic Engineering, Transactions of the ASME, Series D *(U. S.)*

J. Belge Radiol.
*Journal Belge de Radiologie *(Belgium)*

J. Biochem. (Tokyo)
Journal of Biochemistry, The (Tokyo) *(Japan)*

J. Biol. Chem.
*Journal of Biological Chemistry, The *(U. S.)*

J. Bone Joint Surg.
Journal of Bone and Joint Surgery, The *(U. S.)*

J. Brasil. Neurol.
*Journal Brasileiro de Neurologia *(Brazil)*

J. Brasil. Psiquiat.
*Journal Brasileiro de Psiquiatria *(Brazil)*

J. Brit. Interplanet. Soc.
*Journal of the British Interplanetary Society *(England)*

J. Brit. Nucl. Energy Soc.
*Journal of the British Nuclear Energy Society, The (formerly Journal of the British Nuclear Energy Conference) *(England)*

J. Can. Assoc. Radiologists
*Journal of the Canadian Association of Radiologists *(Canada)*

J. Can. Ceram. Soc.
*Journal of the Canadian Ceramic Society *(Canada)*

J. Catalysis
Journal of Catalysis *(U. S.)*

J. Cell Biol.
Journal of Cell Biology, The (formerly Journal of Biophysical and Biochemical Cytology) *(U. S.)*

J. Cellular Comp. Physiol.
*Journal of Cellular and Comparative Physiology *(U. S.)*

J. Ceram. Assoc. Japan
Journal of the Ceramic Association of Japan
see Yogyo Kyokai Shi

J. Chem. Educ.
Journal of Chemical Education *(U. S.)*

J. Chem. Eng. Data
*Journal of Chemical and Engineering Data *(U. S.)*

J. Chem. Phys.
*Journal of Chemical Physics, The *(U. S.)*

J. Chem. Soc.
*Journal of the Chemical Society (London) *(England)*

J. Chem. Soc. Japan
Journal of the Chemical Society of Japan
see Nippon Kagaku Zasshi

J. Chem. Soc. Japan, Ind. Chem. Sect.
Journal of the Chemical Society of Japan, Industrial Chemistry Section
see Kogyo Kagaku Zasshi

J. Chem. Soc. Japan, Pure Chem. Sect.
Journal of the Chemistry Society of Japan, Pure Chemistry Section
see Nippon Kagaku Zasshi

J. Chim. Phys.
*Journal de Chimie Physique et de Physicochimie Biologique *(France)*

J. Chinese Chem. Soc. (Taiwan)
*Journal of the Chinese Chemical Society (Taiwan) *(China)*

J. Christian Med. Assoc. India
Journal of the Christian Medical Association of India *(India)*

J. Chromatog.
*Journal of Chromatography *(Netherlands)*

J. Clin. Endrocrinol. Metab.
*Journal of Clinical Endocrinology and Metabolism, The *(U. S.)*

J. Clin. Invest.
*Journal of Clinical Investigation, The *(U. S.)*

J. Clin. Ophthalmol.
Journal of Clinical Ophthalmology
see Rinsho Ganka

J. Colloid Sci.
*Journal of Colloid Science *(U. S.)*

J. Coll. Radiologists Australasia
Journal of the College of Radiologists of Australasia *(Australia)*

J. Comp. Physiol. Psychol.
Journal of Comparative and Physiological Psychology *(U. S.)*

J. Dairy Sci.
Journal of Dairy Science *(U. S.)*

J. Dental Res.
Journal of Dental Research, The *(U. S.)*

J. Econ. Entomol.
Journal of Economic Entomology *(U. S.)*

J. Egypt. Med. Assoc.
*Journal of the Egyptian Medical Association, The *(Egypt)*

J. Electroanal. Chem.
*Journal of Electroanalytical Chemistry *(Netherlands)*

J. Electrochem. Soc.
*Journal of the Electrochemical Society *(U. S.)*

J. Electrochem. Soc. Japan
Journal of the Electrochemical Society of Japan
see Denki Kagaku

J. Electron. Control
*Journal of Electronics and Control *(U. S.)*

J. Electronmicroscopy (Tokyo)
Journal of Electronmicroscopy (Tokyo) *(Japan)*

J. Embryol. Exptl. Morphol.
*Journal of Embryology and Experimental Morphology *(England)*

Jenaer Rundschau
Jenaer Rundschau *(Germany)*

Jena Rev.
Jena Review
see Jenaer Rundschau

J. Endocrinol.
Journal of Endocrinology, The *(England)*

J. Eng. Ind.
*Journal of Engineering for Industry, Transactions of the ASME, Series B *(U. S.)*

J. Eng. Power
*Journal of Engineering for Power, Transactions of the ASME, Series A *(U. S.)*
J. Exptl. Botany
Journal of Experimental Botany *(England)*
J. Exptl. Med.
*Journal of Experimental Medicine *(U. S.)*
J. Exptl. Zool.
Journal of Experimental Zoology *(U. S.)*
J. Fac. Agr. Hokkaido Univ.
*Journal of the Faculty of Agriculture, Hokkaido University *(Japan)*
J. Fluid Mech.
*Journal of Fluid Mechanics *(U. S.)*
J. Food Sci.
Journal of Food Science (formerly Food Research) *(U. S.)*
J. Forensic Sci.
Journal of Forensic Sciences *(U. S.)*
J. Formosan Med. Assoc.
Journal of the Formosan Medical Association
see ***T'ai-wan I Hsueh Hui Tsa Chih***
J. Four Elec.
Journal du Four Electrique et des Industries Electrochimiques *(France)*
J. Franklin Inst.
*Journal of the Franklin Institute *(U. S.)*
J. Genet.
*Journal of Genetics *(U. S.)*
J. Genet. Psychol.
Journal of Genetic Psychology, The *(U. S.)*
J. Gen. Microbiol.
Journal of General Microbiology *(England)*
J. Gen. Physiol.
Journal of General Physiology *(U. S.)*
J. Geomagnet. Geoelec.
*Journal of Geomagnetism and Geoelectricity *(Japan)*
J. Geophys. Res.
*Journal of Geophysical Research *(U. S.)*
J. Germantown Hosp. (Philadelphia)
Journal of the Germantown Hospital (Philadelphia) *(U. S.)*
J. Gerontol.
*Journal of Gerontology *(U. S.)*
J. Heat Transfer
*Journal of Heat Transfer, Transactions of the ASME, Series C *(U. S.)*
J. Hirnforsch.
Journal fuer Hirnforschung *(Germany)*
J. Hiroshima Med. Assoc.
Journal of the Hiroshima Medical Association, The
see ***Hiroshima Igaku***
J. Histochem. Cytochem.
Journal of Histochemistry and Cytochemistry, The *(U. S.)*
J. Hyg.
Journal of Hygiene, The *(England)*
Jikeikai Med. J.
*Jikeikai Medical Journal *(Japan)*
J. Immunol.
*Journal of Immunology, The *(U. S.)*
J. Indian Chem. Soc.
*Journal of the Indian Chemical Society *(India)*
J. Indian Inst. Sci.
*Journal of the Indian Institute of Science *(India)*
J. Infect. Diseases
Journal of Infectious Diseases, The *(U. S.)*
J. Inorg. Nucl. Chem.
*Journal of Inorganic & Nuclear Chemistry *(England)*
J. Insect Pathol.
Journal of Insect Pathology *(U. S.)*
J. Inst. Elec. Engrs. (London)
Journal of the Institution of Electrical Engineers (London), The *(England)*
J. Inst. Elec. Engrs. Japan
Journal of the Institute of Electric Engineers of Japan, The
see ***Denki Gakkai Zasshi***
J. Inst. Engrs., Australia
*Journal of the Institution of Engineers, Australia *(Australia)*
J. Inst. Metals
*Journal of the Institute of Metals with Bulletin and Metallurgical Abstracts *(England)*
J. Inst. Public Health Engrs.
Journal of the Institution of Public Health Engineers *(England)*
J. Inst. Telecommun. Engrs.
Journal of the Institution of Telecommunication Engineers *(India)*
J. Invest. Dermatol.
Journal of Investigative Dermatology, The *(U. S.)*
J. Iowa State Med. Soc.
Journal of the Iowa State Medical Society, The *(U. S.)*
J. Iron Steel Inst. (Japan)
Journal of the Iron and Steel Institute (Japan)
see ***Tetsu To Hagane***
J. Iron Steel Inst. (London)
Journal of the Iron and Steel Institute (London) *(England)*
J. Japan Assoc. Autom. Control Engrs.
Journal of the Japan Association of Automatic Control Engineers *(Japan)*
J. Japan Inst. Metals (Sendai)
Journal of the Japan Institute of Metals (Sendai)
see ***Nippon Kinzoku Gakkaishi***
J. Japan. Obstet. Gynecol. Soc.
Journal of the Japanese Obstetrical and Gynecological Society (English edition of Nippon Sanfujinka Zasshi) *(Japan)*
J. Japan. Soc. Food Nutr.
Journal of the Japanese Society of Food and Nutrition
see ***Eiyo To Shokuryo***
J. Japan Soc. Mech. Engrs.
Journal of the Japan Society of Mechanical Engineers
see ***Nippon Kikai Gakkai-shi***
J. Japan Soc. Powder Met.
Journal of Japan Society of Powder Metallurgy
see ***Funtai Oyobi Funmatsuyakin***
J. Japan Welding Soc.
Journal of the Japan Welding Society
see ***Yosetsu Gakkaishi***
J. Joint Panel Nucl. Marine Propulsion
*Journal of the Joint Panel on Nuclear Marine Propulsion *(England)*
J. Korean Med. Assoc.
Journal of the Korean Medical Association *(Korea)*
J. Kyushu Hematol. Soc.
Journal of Kyushu Hematological Society, The
see ***Kyushu Ketsueki Kenkyu Dokokai-shi***
J. Lab. Clin. Med.
*Journal of Laboratory and Clinical Medicine, The *(U. S.)*
J. Lancet
Journal-Lancet, The *(U. S.)*
J. Less-Common Metals
*Journal of the Less-Common Metals *(Netherlands)*
J. Madras Univ., B
Journal of the Madras University, B *(India)*
J. Marine Biol. Assoc. U. K.
Journal of the Marine Biological Association of the United Kingdom *(England)*
J. Math. Anal. Appl.
*Journal of Mathematical Analysis and Applications *(U. S.)*
J. Math. Mech.
Journal of Mathematics and Mechanics *(U. S.)*
J. Math. Phys. (N. Y.)
*Journal of Mathematical Physics (New York) *(U. S.)*
J. Mecan.
*Journal de Mecanique *(France)*
J. Mech. Phys. Solids
Journal of the Mechanics and Physics of Solids *(England)*
J. Med. Assoc. Georgia
Journal of the Medical Association of Georgia, The *(U. S.)*
J. Med. Chem.
Journal of Medicinal Chemistry *(U. S.)*
J. Med. Lab. Technol.
Journal of Medical Laboratory Technology *(England)*
J. Metals
*Journal of Metals *(U. S.)*
J. Meteorol.
*Journal of Meteorology, The *(U. S.)*
J. Meteorol. Res.
Journal of Meteorological Research
see ***Kishocho Kenkyu Jiho***
J. Microscopie
Journal de Microscopie *(France)*
J. Mining Met. Inst. Japan
Journal of Mining and Metallurgical Institute of Japan
see ***Nippon Kogyo Kaishi***
J. Mississippi State Med. Assoc.
Journal of the Mississippi State Medical Association *(U. S.)*

J. Mol. Biol.
*Journal of Molecular Biology *(England)*
J. Mol. Spectry.
*Journal of Molecular Spectroscopy *(U. S.)*
J. Mt. Sinai Hosp., N. Y.
Journal of the Mount Sinai Hospital, New York *(U. S.)*
J. Nagasaki Med. Assoc.
Journal of the Nagasaki Medical Association
see ***Nagasaki Igakkai Zasshi***
J. Nara Med. Assoc.
Journal of the Nara Medical Association, The
see ***Nara Igaku Zasshi***
J. Natl. Cancer Inst.
*Journal of the National Cancer Institute *(U. S.)*
J. Natl. Med. Assoc.
Journal of the National Medical Association *(U. S.)*
J. Natl. Res. Council Thailand
*Journal of the National Research Council of Thailand (contains Part I. Natural Science and Part II. Social Science, paged separately) *(Thailand)*
J. Nat. Sci. Math.
*Journal of Natural Sciences and Mathematics *(Pakistan)*
J. N. D. I. (Japan)
Journal of N. D. I. (Japan)
see ***Hi-hakai Kensa***
J. Neurochem.
Journal of Neurochemistry *(England)*
J. Neuropathol. Exptl. Neurol.
Journal of Neuropathology and Experimental Neurology, The *(U. S.)*
J. Neurosurg.
Journal of Neurosurgery *(U. S.)*
J. Newark Beth Israel Hosp.
Journal of the Newark Beth Israel Hospital *(U. S.)*
J. Nucl. Energy: Pt. A & B
*Journal of Nuclear Energy: Parts A & B. Reactor Science and Technology (formerly issued separately) *(England)*
J. Nucl. Energy: Pt. C
*Journal of Nuclear Energy: Part C. Plasma Physics–Accelerators–Thermonuclear Research *(England)*
J. Nucl. Mater.
*Journal of Nuclear Materials (Journal des Materiaux Nucleaires) *(Netherlands)*
J. Nucl. Med.
*Journal of Nuclear Medicine *(U. S.)*
J. Nucl. Sci. Technol. (Tokyo)
*Journal of Nuclear Science and Technology (Tokyo) *(Japan)*
J. Nutr.
Journal of Nutrition, The *(U. S.)*
J. Obstet. Gynaecol. Brit. Commonwealth
Journal of Obstetrics and Gynaecology of the British Commonwealth *(England)*
J. Occupational Med.
Journal of Occupational Medicine *(U. S.)*
J. Oceanog. Soc. Japan
Journal of the Oceanographical Society of Japan *(Japan)*
J. Okayama Med. Soc.
Journal of Okayama Medical Society
see ***Okayama Igakkai Zasshi***
J. Oklahoma State Med. Assoc.
Journal of the Oklahoma State Medical Association, The *(U. S.)*
J. Opt. Soc. Am.
*Journal of the Optical Society of America *(U. S.)*
J. Oral Surg. Anesthesia Hosp. Dental Serv.
Journal of Oral Surgery, Anesthesia and Hospital Dental Service (formerly Journal of Oral Surgery) *(U. S.)*
J. Org. Chem.
*Journal of Organic Chemistry, The *(U. S.)*
J. Osaka City Med. Center
Journal of the Osaka City Medical Center, The
see ***Osaka Shiritsu Daigaku Igaku Zasshi***
J. Pakistan Med. Assoc.
Journal of the Pakistan Medical Association *(Pakistan)*
J. Parasitol.
Journal of Parasitology, The *(U. S.)*
J. Pathol. Bacteriol.
Journal of Pathology and Bacteriology, The *(Scotland)*
J. Periodontol.
Journal of Periodontology, The *(U. S.)*
J. Petrol. Technol.
Journal of Petroleum Technology *(U. S.)*
J. Pharmacol. Exptl. Therap.
Journal of Pharmacology and Experimental Therapeutics, The *(U. S.)*
J. Pharm. Belg.
Journal de Pharmacie de Belgique *(Belgium)*
J. Pharm. Pharmacol.
Journal of Pharmacy and Pharmacology *(England)*
J. Pharm. Sci.
Journal of Pharmaceutical Sciences *(U. S.)*
J. Pharm. Soc. Japan
Journal of the Pharmaceutical Society of Japan
see ***Yakugaku Zasshi***
J. Phot. Sci.
Journal of Photographic Science *(England)*
J. Phys. (Paris)
*Journal de Physique (Paris) (formerly Le Journal de Physique et le Radium) *(France)*
J. Phys. Chem.
*Journal of Physical Chemistry, The *(U. S.)*
J. Phys. Chem. Solids
*Journal of Physics and Chemistry of Solids (formerly Physics and Chemistry of Solids, The) *(U. S.)*
J. Physiol. (London)
Journal of Physiology, The (London) *(England)*
J. Physiol. (Paris)
Journal de Physiologie (Paris) *(France)*
J. Physiol. Soc. Japan
Journal of the Physiological Society of Japan
see ***Nippon Seirigaku Zasshi***
J. Phys., Phys. Appl. (Paris)
*Journal de Physique, Physique Appliqué (Paris). Supplement au Journal de Physique (Paris) *(France)*
J. Phys. Radium
Journal de Physique, Le, et Le Radium *(France)*
J. Phys. Soc. Japan
*Journal of the Physical Society of Japan
J. Polymer Sci. Pt. A
*Journal of Polymer Science. Part A: General Papers *(U. S.)*
J. Polymer Sci. Pt. B
*Journal of Polymer Science. Part B: Polymer Letters *(U. S.)*
J. Polymer Sci. Pt. C
*Journal of Polymer Science. Part C: Polymer Symposia *(U. S.)*
J. Prakt. Chem.
Journal fuer Praktische Chemie *(Germany)*
J. Proc. Roy. Soc. N. S. Wales
*Journal and Proceedings of the Royal Society of New South Wales *(Australia)*
J. Prosthetic Dentistry
Journal of Prosthetic Dentistry, The *(U. S.)*
J. Quant. Spectry. Radiative Transfer
*Journal of Quantitative Spectroscopy & Radiative Transfer *(England)*
J. Radiation Res. (Japan)
*Journal of Radiation Research *(Japan)*
J. Radiol., Electrol. Med. Nucl.
*Journal de Radiologie, d'Electrologie, et de Medicine Nucleaire *(France)*
J. Reprod. Fertility
Journal of Reproduction and Fertility *(England)*
J. Res. (Japan)
Journal of Research (Japan)
see ***Kenkyukiho***
J. Res. Inst. Catalysis, Hokkaido Univ.
*Journal of the Research Institute for Catalysis, Hokkaido University *(Japan)*
J. Res. Natl. Bur. Std.
*Journal of Research of the National Bureau of Standards (now divided into the following sections: A. Physics and Chemistry; B. Mathematics and Mathematical Physics; C. Engineering and Instrumentation; and D. Radio Science (formerly Radio Propagation)) *(U. S.)*
J. Reticuloendothelial Soc.
*Journal of the Reticuloendothelial Society *(U. S.)*
J. Roy. Army Med. Corps
Journal of the Royal Army Medical Corps *(England)*
J. Roy. Army Vet. Corps
Journal of the Royal Army Veterinary Corps *(England)*
J. S. Carolina Med. Assoc.
Journal of the South Carolina Medical Association, The *(U. S.)*
J. Sci. Food Agr.
*Journal of the Science of Food and Agriculture *(England)*

J. Sci. Hiroshima Univ. Ser. A-II
*Journal of Science of the Hiroshima University. Series A-II *(Japan)*

J. Sci. Ind. Res. (India)
*Journal of Scientific and Industrial Research *(India)*

J. Sci. Instr.
*Journal of Scientific Instruments *(England)*

J. Sci. Med. Lille
Journal des Sciences Medicales de Lille *(France)*

J. Sericult. Sci. Japan
Journal of Sericultural Science of Japan
see *Nippon Sanshigaku Zasshi*

J. Showa Med. Assoc.
Journal of the Showa Medical Association, The
see *Showa Igakukai Zasshi*

J. Soc. Cosmetic Chemists
Journal of the Society of Cosmetic Chemists *(England)*

J. Soc. Mater. Sci., Japan
Journal of the Society of Materials Science, Japan *(Japan)*

J. Soc. Rubber Ind. Japan
Journal of the Society of Rubber Industry of Japan
see *Nippon Gomu Kyokaishi*

J. Soc. Textile Cellulose Ind. Japan
Journal of the Society of Textile and Cellulose Industries, Japan
see *Seni-i Gakkaishi*

J. Spacecraft Rockets
Journal of Spacecraft and Rockets *(U. S.)*

J. Spectroscopical Soc. Japan
Journal of the Spectroscopical Society of Japan
see *Bunko Kenkyu*

J. Suisse Horl.
Journal Suisse d'Horlogerie *(Switzerland)*

J. Surg. Res.
Journal of Surgical Research *(U. S.)*

J. Tenn. Acad. Sci.
*Journal of the Tennessee Academy of Science *(U. S.)*

J. Theoret. Biol.
*Journal of Theoretical Biology *(England)*

J. Trauma
Journal of Trauma *(U. S.)*

J. Ultrastruct. Res.
*Journal of Ultrastructure Research *(U. S.)*

J. Urol.
Journal of Urology, The *(U. S.)*

J. Vacuum Sci. Technol.
*Journal of Vacuum Science and Technology, The *(U. S.)*

J. Vacuum Soc. Japan
Journal of the Vacuum Society of Japan
see *Shinku*

J. Water Pollution Control Federation
Journal of the Water Pollution Control Federation (formerly Sewage and Industrial Wastes) *(U. S.)*

J. Wildlife Management
Journal of Wildlife Management, The *(U. S.)*

Kaeltetechnik
Kaeltetechnik *(Germany)*

Kagaku (Tokyo)
Kagaku (Tokyo) (Science) *(Japan)*

Kagaku Kogyo
Kagaku Kogyo (Chemical Industry) *(Japan)*

Kagaku to Kogyo (Tokyo)
Kagaku to Kogyo (Tokyo) (Chemistry and Chemical Industry) *(Japan)*

Kakuyugo-Kenkyu
Kakuyugo-Kenkyu *(Japan)*

Kansas State Univ., Eng. Expt. Sta., Spec. Rept.
Kansas State University, Engineering Experiment Station, Special Report *(U. S.)*

Karyoku Hatsuden
Karyoku Hatsuden (Thermal Power, The) *(Japan)*

Kauchuk i Rezina
Kauchuk i Rezina† *(U.S.S.R.)*

Keio J. Med.
*Keio Journal of Medicine, The *(Japan)*

Kenkyukiho
Kenkyukiho (Journal of Research) *(Japan)*

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Keramische Zeitschrift *(Germany)*

Kernenergie
*Kernenergie *(Germany)*

Kerntechnik
*Kerntechnik, Isotopentechnik und -Chemie *(Germany)*

Kexue Tongbao
Kexue Tongbao (Science, General Reports) *(China)*

KFKI Kozlemen.
KFKI Kozlemenyei
see *Mag. Tud. Akad. Kozp. Fiz. Kut. Int. Kozlemen.*

Kgl. Danske Videnskab. Selskab, Mat.-Fys. Medd.
*Kongelige Danske Videnskabernes Selskab, Det, Matematisk-fysiske Meddelelser *(Denmark)*

Kgl. Danske Videnskab. Selskab, Mat. Fys. Skrifter
*Kongelige Danske Videnskabernes Selskab, Det, Matematisk-Fysiske Skrifter *(Denmark)*

Kgl. Norske Videnskab. Selskabs, Forh.
*Kongelige Norske Videnskabers Selskabs, Det, Forhandlinger *(Norway)*

Khim. i Prakt. Primenenie Kremneorgan. Soedin., Tr. Konf., Leningrad, 1958
Khimiya i Prakticheskoe Primenenie Kremneorganicheskikh Soedinenii, Trudy Konferentsii, Leningrad, Sept. 25-27, 1958 (No. 6 Pub. 1961) *(U.S.S.R.)*

Khim. Prom.
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Khim. Volokna
Khimicheskie Volokna *(U.S.S.R.)*

Khim. Zemnoi Kory, Akad. Nauk SSSR, Tr. Geokhim. Konf.
Khimiya Zemnoi Kory, Akademiya Nauk SSSR, Trudy Geokhimicheskoi Konferentsii *(U.S.S.R.)*

Khirurgiya (Sofia)
Khirurgiya (Sofia) *(Bulgaria)*

Khlopkovodstvo
Khlopkovodstvo *(U.S.S.R.)*

Kiel. Milchwirtsch. Forschungsber.
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Kinetika i Kataliz
*Kinetika i Kataliz† *(U.S.S.R.)*

Kinzoku Zairyo Gijutsu Kenkyusho Kenkyu Hokoku
Kinzoku Zairyo Gijutsu Kenkyusho Kenkyu Hokoku (Report of National Research Institute for Metals) *(Japan)*

Kiserl. Orvostud.
Kiserletes Orvostudomany *(Hungary)*

Kishocho Kenkyu Jiho
Kishocho Kenkyu Jiho (Journal of Meteorological Research) *(Japan)*

Kitakanto Igaku
Kitakanto Igaku (Kitakanto Medical Journal) *(Japan)*

Kitakanto Med. J.
Kitakanto Medical Journal
see *Kitakanto Igaku*

Klin. Med. (Vienna)
Klinische Medizin (Vienna) *(Austria)*

Klin. Wochschr.
*Klinische Wochenschrift *(Germany)*

Kobunshi Kagaku
Kobunshi Kagaku (Chemistry of High Polymers) *(Japan)*

Kogyo Gijutsuin Sen'i Kogyo Shikensho Kenkyu Hokoku
Kogyo Gijutsuin Sen'i Kogyo Shikensho Kenkyu Hokoku (Bulletin of the Textile Research Institute of Japanese Government) *(Japan)*

Kogyo Kagaku Zasshi
Kogyo Kagaku Zasshi (Journal of the Chemical Society of Japan, Industrial Chemistry Section) *(Japan)*

Kohasz. Lapok
Kohaszati Lapok *(Hungary)*

K'o Hsueh T'ung Pao
*K'o Hsueh T'ung Pao (Scientia) *(China)*

Kolloidn. Zh.
*Kolloidnyi Zhurnal† *(U.S.S.R.)*

Kolloid-Z.
Kolloid-Zeitschrift *(Germany)*

Koloriszt. Ertesito
Kolorisztikai Ertesito *(Hungary)*

Kommunist Tadzh.
Kommunist Tadzhikistana *(Tadzhik S.S.R.)*

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Komsomol'skoe Znamya *(Ukrainian S.S.R.)*

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Koninklijke Nederlandse Akademie van Wetenschappen, Proceedings, Series B *(Netherlands)*

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Koninklijke Nederlandse Akademie van Wetenschappen, Proceedings, Series C *(Netherlands)*

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Korrosion und Metallschutz unter Einbeziehung des Allgemeinen Werkstoffschutzes *(Germany)*

Koshu Eiseiin Kenkyu Hokoku
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Kosmich. Issled.
*Kosmicheskie Issledovaniya *(U.S.S.R.)*

Kosmos (Stockholm)
Kosmos (Stockholm) *(Sweden)*

Kosmos (Warsaw) Ser. A
*Kosmos (Warsaw) Seria A: Biologia *(Poland)*

Kozarstvi
Kozarstvi *(Czechoslovakia)*

Kozp. Elelmiszeripari Kutatoint. Kozlemen.
Kozponti Elelmiszeripari Kutatointezet Kozlemenyei, A *(Hungary)*

Krajowe Symp. Zastosowan Izotopow Tech., 1-sze Rogow, Pol., 1960
Krajowe Sympozjum Zastosowan Izotopow w Technice, 1-sze [i.e., Pierwsze] Sympozjum, Rogow, Pol., June 8-12, 1960 ([Pub. 1961]) *(Poland)*

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Krebsarzt, Der *(Austria)*

Kristallografiya
Kristallografiya† *(U.S.S.R.)*

Kromosoma (Japan)
Kromosoma, (Japan) La
see ***Senshokutai***

Krupp Tech. Rev. (English Transl. Tech. Mitt. Krupp, Werksber.)
*Krupp Technical Review (English Translation of Technische Mitteilungen Krupp, Werksberichte) *(Germany)*

Kuki Chowa, Eisei Kogaku
Kuki Chowa, Eisei Kogaku (Air Conditioning, Sanitary Engineering) *(Japan)*

Kumamoto Med. J.
Kumamoto Medical Journal, The *(Japan)*

Kunststoffe
Kunststoffe *(Germany)*

Kwart. Geol.
*Kwartalnik Geologiczny *(Poland)*

Kyushu J. Med. Sci.
Kyushu Journal of Medical Science *(Japan)*

Kyushu Ketsueki Kenkyu Dokokai-shi
Kyushu Ketsueki Kenkyu Dokokai-shi (The Journal of Kyushu Hematological Society) *(Japan)*

Lab. Animal Care
Laboratory Animal Care *(U. S.)*

Lab. Delo
Laboratornoe Delo *(U.S.S.R.)*

Lab. Invest.
*Laboratory Investigation *(U. S.)*

Lab. Management
Laboratory Management *(U. S.)*

Lab. Pract.
Laboratory Practice *(England)*

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Lakokrasochnye Materialy i ikh Primenenie *(U.S.S.R.)*

Lancet
Lancet, The *(England)*

Land Econ.
Land Economics *(U. S.)*

Laryngoscope
Laryngoscope, The *(U. S.)*

Lastechniek
Lastechniek *(Netherlands)*

Latvijas PSR Zinatnu Akad. Vestis
*Latvijas PSR Zinatnu Akademijas Vestis *(Latvian S.S.R.)*

Latvijas PSR Zinatnu Akad. Vestis, Fiz. Tek. Zinatnu Ser.
*Latvijas PSR Zinatnu Akademijas Vestis, Fizikas un Teknisko Zinatnu Serija *(Latvian S.S.R.)*

Laval Med.
Laval Medical *(Canada)*

Lead
Lead *(U. S.)*

Lectures Sci. Basis Med.
Lectures on the Scientific Basis of Medicine *(England)*

Lekar. Obzor
Lekarsky Obzor *(Czechoslovakia)*

Lekarsk. Veda Zahranici
Lekarska Veda v Zahranici (issued with Casopis Lekaru Ceskych) *(Czechoslovakia)*

Lekarz Wojskowy
Lekarz Wojskowy *(Poland)*

Lietuvos Fiz. Rinkinys, Lietuvos TSR Mokslu Akad., Lietuvos TSR Aukstosios Mokyklos
*Lietuvos Fizikos Rinkinys, Lietuvos TSR Mokslu Akademija, Lietuvos TSR Aukstosios Mokyklos *(Lithuanian S.S.R.)*

Lietuvos TSR Aukstuju Mokyklu Mokslo Darbai, Geogr. ir Geol.
Lietuvos TSR Aukstuju Mokyklu Mokslo Darbai, Geografija ir Geologija *(Lithuanian S.S.R.)*

Lietuvos TSR Mokslu Akad. Darbai: Ser. B
*Lietuvos TSR Mokslu Akademija Darbai: Serija B *(Lithuanian S.S.R.)*

Lietuvos TSR Sveikatos Apsaugos Min., Onkol. Inst. Darbai
Lietuvos TSR Sveikatos Apsaugos Ministerija, Onkologijos Instituto Darbai *(Lithuanian S.S.R.)*

Life Sci.
Life Sciences *(U. S.)*

Light Metals
Light Metals *(England)*

Lijecnicki Vjesnik
Lijecnicki Vjesnik *(Yugoslavia)*

Lille Med.
*Lille Medical *(France)*

Limnol. Oceanog.
*Limnology and Oceanography *(U. S.)*

Limnologica (Berlin)
Limnologica (Berlin) *(Germany)*

Litovsk. Mat. Sb.
*Litovskii Matematicheskikh Sbornik *(Lithuanian S.S.R.)*

Lodz. Towarz. Nauk, Wydzial III, Acta Chim.
*Lodzkie Towarzystwo Naukowe, Wydzial III, Acta Chimica *(Poland)*

London Clin. Med. J.
London Clinic Medical Journal *(England)*

Lyon Med.
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Machine Design
Machine Design *(U. S.)*

Machinery (Engl.)
Machinery *(England)*

Machinery Lloyd
*Machinery Lloyd *(England)*

Madjalah Inst. Tekn. Bandung Proc.
*Madjalah Institut Teknologi Bandung Proceedings *(Indonesia)*

Magy. Belorv. Arch.
Magyar Belorvosi Archivum *(Hungary)*

Magy. Fiz. Folyoirat
*Magyar Fizikai Folyoirat *(Hungary)*

Magy. Kem. Folyoirat
*Magyar Kemiai Folyoirat *(Hungary)*

Magy. Kem. Lapja
*Magyar Kemikusok Lapja *(Hungary)*

Magy. Radiol.
*Magyar Radiologia *(Hungary)*

Magy. Tud. Akad. At. Kut. Int. (Debrecen). Kozlemen.
Magyar Tudomanyos Akademia Atommag Kutato Intezete (Debrecen). Kozlemenyek
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Magy. Tud. Akad. Kem. Tud. Oszt. Kozlemen.
Magyar Tudomanyos Akademia, Kemiai Tudomanyok Osztalyanak, Kozlemenyei, A *(Hungary)*

Magy. Tud. Akad. Kozp. Fiz. Kut. Int. Kozlemen.
*Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezetenek Kozlemenyei *(Hungary)*

Magy. Tud. Akad. Muszaki Tud. Oszt. Kozlemenyei
*Magyar Tudomanyos Akademia Muszaki Tudomanyok Osztalyanak Kozlemenyei *(Hungary)*

Mal. Cardiovascolari
*Malattie Cardiovascolari *(Italy)*
Manchester Med. Gaz.
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Maryland State Med. J.
Maryland State Medical Journal *(U. S.)*
Mass Spectry. (Tokyo)
Mass Spectroscopy (Tokyo)
see Shitsuryo Bunseki
Mater. Design Eng.
*Materials in Design Engineering (formerly Materials & Methods) *(U. S.)*
Mater. Evaluation
*Materials Evaluation (formerly Nondestructive Testing) *(U. S.)*
Materialy po Toksikol. Radioaktivn. Veshchestv, Inst. Gigieny Truda i Profzabolevanii Akad. Med. Nauk SSSR
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Maternidade Infancia
Maternidade e Infancia *(Brazil)*
Mater. Res. Std.
*Materials Research & Standards (Formerly ASTM (American Society for Testing Materials) Bulletin) *(U. S.)*
Math. Computation
Mathematics of Computation *(U. S.)*
Mechanik
Mechanik *(Poland)*
Mech. Eng.
Mechanical Engineering *(U. S.)*
Mech. World Eng. Record
Mechanical World & Engineering Record *(England)*
Med. Ann. District Columbia
Medical Annals of the District of Columbia *(U. S.)*
Med. Biol. (Tokyo)
Medicine and Biology (Tokyo)
see Igaku To Seibutsugaku
Med. Clin. (Barcelona)
Medicina Clinica (Barcelona) *(Spain)*
Med. Clin. N. Am.
Medical Clinics of North America, The *(U. S.)*
Med. Doswiadczalna Mikrobiol.
*Medycyna Doswiadczalna i Mikrobiologia *(Poland)*
Medd. Sundhedsstyr.
Meddelelser fra Sundhedsstyrelsen (Supplement to Ugeskrift for Laeger) *(Denmark)*
Med. Electron. Biol. Eng.
*Medical Electronics & Biological Engineering *(England)*
Med. Exptl.
*Medicina Experimentalis *(Switzerland)*
Medicamundi
*Medicamundi *(Netherlands)*
Medicina (Madrid)
Medicina (Madrid) *(Spain)*
Medicina (Mex.)
*Medicina *(Mexico)*
Medicine (Tokyo)
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see Soao Igaku
Med. J. Australia
Medical Journal of Australia, The *(Australia)*
Med. J. Hiroshima Univ.
*Medical Journal of Hiroshima University *(Japan)*
Med. J. Malaya
*Medical Journal of Malaya, The *(Malaya)*
Med. J. Osaka Univ.
Medical Journal of Osaka University
see Osaka Daigaku Igaku Zasshi
Med. J. Shinshu Univ.
*Medical Journal of Shinshu University *(Japan)*
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Medizinische Klinik (Munich) *(Germany)*
Med. Lavoro
Medicina del Lavoro, La *(Italy)*
Med. Monatsschr.
Medizinische Monatsschrift *(Germany)*
Med. Mundi
Medica Mundi *(Netherlands)*
Med. Periskop (Ingelheim)
Medizinische Periskop (Ingelheim) *(Germany)*
Med. Pracy
*Medycyna Pracy *(Poland)*
Med. Prom. SSSR
Meditsinskaya Promyshlennost SSSR *(U.S.S.R.)*
Med. Radiol.
*Meditsinskaya Radiologiya† *(U.S.S.R.)*
Med. Sci. (Philadelphia)
Medical Science (Philadelphia) *(U. S.)*
Med. Serv. J. (Can.)
Medical Service Journal *(Canada)*
Med. Times
Medical Times *(U. S.)*
Med. Treat. (Tokyo)
Medical Treatment (Tokyo)
see Iryo (Tokyo)
Med. Welt
Medizinsche Welt, Die *(Germany)*
Med. Zh. Uzbekistana
Meditsinskii Zhurnal Uzbekistana *(Uzbek S.S.R.)*
Meidensha Jiho
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see Meidensha Jiho
Meiji Daigaku Nogakubu Kenkyu Hokoku
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Mem. Acad. Roy. Med. Belg.
*Memoires de l'Academie Royale de Medecine de Belgique *(Belgium)*
Mem. Actividades Desarrolladas Patronato "Juan de la Cierva" Invest. Tec., Consejo Super. Invest. Cient.
*Memoria de las Actividades Desarrolladas por el Patronato "Juan de la Cierva" de Investigacion Tecnica, Consejo Superior de Investigaciones Cientificas *(Spain)*
Mem. Coll. Sci., Univ. Kyoto, Ser. B
*Memoirs of the College of Science, University of Kyoto, Series B *(Japan)*
Mem. Fac. Agr., Hokkaido Univ.
*Memoirs of the Faculty of Agriculture, Hokkaido University *(Japan)*
Mem. Fac. Eng., Kyoto Univ.
Memoirs of the Faculty of Engineering, Kyoto University *(Japan)*
Mem. Fac. Eng., Nagoya Univ.
Memoirs of the Faculty of Engineering, Nagoya University *(Japan)*
Mem. Fac. Sci., Kyushu Univ. Ser. B
*Memoirs of the Faculty of Science, Kyushu University. Series B *(Japan)*
Mem. Inst. Sci. Ind. Res. Osaka Univ.
Memoirs of the Institute of Scientific and Industrial Research, Osaka University *(Japan)*
Mem. Konan Univ., Sci. Ser.
Memoirs of the Konan University, Science Series *(Japan)*
Mem. Real Acad. Cienc. Artes Barcelona
Memorias de la Real Academia de Ciencias y Artes de Barcelona *(Spain)*
Mem. Sci. Rev. Met.
*Memoires Scientifiques de la Revue de Metallurgie, Les (formerly a part of Revue de Metallurgie) *(France)*
Mem. Soc. Roy. Sci. Liege
*Memoires de la Societe Royale des Sciences de Liege *(Belgium)*
Mem. Soc. Vaudoise Sci. Nat.
*Memoires de la Societe Vaudoise des Sciences Naturelles *(Switzerland)*
Messen, Steuern, Regeln
Messen, Steuern, Regeln *(Germany)*
Metab., Clin. Exptl.
Metabolism, Clinical and Experimental *(U. S.)*
Metalen
Metalen *(Netherlands)*
Metal Ind. (London)
Metal Industry, The (London) *(England)*

Metall
*Metall *(Germany)*
Metalloved. i Term. Obrabotka Metal.
*Metallovedenie i Termicheskaya Obrabotka Metallov† (formerly Metallovedenie i Obrabotka Metallov) *(U.S.S.R.)*
Metallurg
Metallurg† *(U.S.S.R.)*
Metallurgia
*Metallurgia *(England)*
Metal Progr.
*Metal Progress *(U. S.)*
Metal Sci. Heat Treat. Metals (USSR) (English Transl.)
Metal Science and Heat Treatment of Metals (USSR) (English Translation of Metallovedenie i Termicheskaya Obrabotka Metallov) *(U. S.)*
Metals Eng. Quart.
*Metals Engineering Quarterly *(U. S.)*
Metal Treat. Drop Forging
Metal Treatment and Drop Forging *(England)*
Metalworking Prod.
Metalworking Production *(England)*
Metaux (Corrosion-Ind.)
*Metaux (Corrosion-Industries) *(France)*
Meteoritics
Meteoritics *(U. S.)*
Meteorol. i Gidrol.
Meteorologiya i Gidrologiya *(U.S.S.R.)*
Meteorologie
Meteorologie, La *(France)*
Meteorol. Rundschau
Meteorologische Rundschau *(Germany)*
Met. i Metalloved. Chistykh Metal., Sb. Nauchn. Rabot
Metallurgiya i Metallovedenie Chistykh Metallov, Moskovskii Inzhenerno-Fizicheskii Institut, Sbornik Nauchnykh Rabot *(U.S.S.R.)*
Met. Ital.
*Metallurgia Italiana, La *(Italy)*
Meteorol. Zpravy
Meteorologicke Zpravy *(Czechoslovakia)*
Metody Polucheniya Radioaktivn. Preparatov, Sb. Statei
Metody Polucheniya Radioaktivnykh Preparatov, Sbornik Statei *(U.S.S.R.)*
Met. Rev.
*Metallurgical Reviews *(England)*
Metrol. Apl. (Bucharest)
Metrologia Aplicata (Bucharest) *(Romania)*
Met. Soc., Am. Inst. Mining, Met. Petrol. Engrs., Inst. Metals Div., Spec. Rept. Ser.
Metallurgical Society, American Institute of Mining, Metallurgical and Petroleum Engineers, Institute of Metals Division, Special Report Series *(U. S.)*
Microchem. J.
*Microchemical Journal *(U. S.)*
Microtecnic
Microtecnic *(Switzerland)*
Mikrobiologiya
Mikrobiologiya† *(U.S.S.R.)*
Mikrochim. Ichnoanal. Acta
*Mikrochimica et Ichnoanalytica Acta (formerly Mikrochimica Acta) *(Austria)*
Milchwissenschaft
Milchwissenschaft *(Germany)*
Military Med.
Military Medicine *(U. S.)*
Minerva Chir.
Minerva Chirgica *(Italy)*
Minerva Dermatol.
Minerva Dermatologica *(Italy)*
Minerva Fisioterap.
Minerva Fisioterapica *(Italy)*
Minerva Gastroenterol.
Minerva Gastroenterologica *(Italy)*
Minerva Ginecol.
Minerva Ginecologica *(Italy)*
Minerva Med.
Minerva Medica *(Italy)*
Minerva Nucl.
*Minerva Nucleare *(Italy)*
Minerva Otorinolaringol.
Minerva Otorinolaringologica *(Italy)*
Minerva Pediat.
Minerva Pediatrica *(Italy)*
Minerva Radiol., Fisioterap. Radiobiol.
*Minerva Radiologica, Fisioterapica e Radiobiologica *(Italy)*
Mining, Elec. Mech. Engr.
Mining, Electrical and Mechanical Engineer *(England)*
Mining Eng.
Mining Engineering *(U. S.)*
Mining Safety (Japan)
Mining and Safety (Japan)
see Saiko To Hoan
Missili
Missili *(Italy)*
Missouri Med.
Missouri Medicine *(U. S.)*
Mitsubishi Denki Giho
Mitsubishi Denki Giho *(Japan)*
Mitsubishi Denki Lab. Rept.
Mitsubishi Denki Laboratory Reports *(Japan)*
Mitsubishi Nippon Juko Giho
Mitsubishi Nippon Juko Giho (Technical Review, Mitsubishi Nippon Heavy-Industries) *(Japan)*
Mitteilungsbl. Strahlungsmessgeraete
*Mitteilungsblaetter Strahlungsmessgeraete *(Germany)*
Mitt. Oesterr. Sanitaetsverwalt.
Mitteilungen der Oesterreischen Sanitaetsverwaltung *(Austria)*
Mitt. Ver. Deut. Emailfachleute
Mitteilungen des Vereins Deutscher Emailfachleute *(Germany)*
Mitt. Ver. Grosskesselbesitzer
Mitteilungen der Vereinigung der Grosskesselbesitzer *(Germany)*
Miyazaki Daigaku Nogakubu, Kenkyu Jiho
Miyazaki Daigaku Nogakubu, Kenkyu Jiho (Bulletin of the Faculty of Agriculture, University of Miyazaki) *(Japan)*
Mizushori Gijutsu
Mizushori Gijutsu *(Japan)*
Mod. Castings
Modern Castings *(U. S.)*
Mod. Hosp.
Modern Hospital *(U. S.)*
Mod. Power Eng.
*Modern Power and Engineering *(Canada)*
Mol. Phys.
*Molecular Physics *(U. S.)*
Monatsber. Deut. Akad. Wiss. Berlin
*Monatsberichte der Deutschen Akademie der Wissenschaften su Berlin *(Germany)*
Monatsh. Chem.
Monatshefte fuer Chemie und Verwandte Teile Anderer Wissenschaften *(Austria)*
Monatsschr. Kinderheilk.
Monatsschrift fuer Kinderheilkunde *(Germany)*
Monatsschr. Ohrenheilk. Laryngo-Rhinol.
Monatsschrift fuer Ohrenheilkunde und Laryngo-Rhinologie *(Austria)*
Monthly Notices Roy. Astron. Soc.
*Monthly Notices of the Royal Astronomical Society *(England)*
Montpellier Med.
*Montpellier Medical *(France)*
Mosquito News
Mosquito News *(U. S.)*
Muench. Med. Wochschr.
Muenchener Medizinische Wochenschrift *(Germany)*
Nafta (Zagreb)
Nafta (Zagreb) *(Yugoslavia)*
Nagasaki Igakkai Zasshi
Nagasaki Igakkai Zasshi (Journal of the Nagasaki Medical Association) *(Japan)*
Nagoya J. Med. Sci.
Nagoya Journal of Medical Science, The *(Japan)*
Nagoya Kogyo Gijutsu Shikensho Hokoku
Nagoya Kogyo Gijutsu Shikensho Hokoku (Reports of the Government Industrial Research Institute, Nagoya) *(Japan)*
Nagoya Med. J.
Nagoya Medical Journal *(Japan)*
Nahrung
Nahrung, Die *(Germany)*

Nara Igaku Zasshi
Nara Igaku Zasshi (The Journal of the Nara Medical Association) *(Japan)*

Natl. Cancer Inst. Monograph
National Cancer Institute Monograph *(U. S.)*

Natl. Defense Med. J. (Japan)
National Defense Medical Journal (Japan)
see *Boei Eisei*

Natl. Inst. Animal Health Quart.
*National Institute of Animal Health Quarterly (Tokyo) *(Japan)*

Natl. Tech. Rept. (Matsushita Elec. Ind. Co., Osaka)
National Technical Report (Matsushita Electric Industrial Co., Osaka) *(Japan)*

Natura, Ser. Biol.
Natura, Seria Biologie *(Romania)*

Nature
*Nature (London) *(England)*

Nature (Tokyo)
Nature (Tokyo)
see *Shizen*

Naturwissenschaften
*Naturwissenschaften, Die *(Germany)*

Nauchn. Dokl. Vysshei Shkoly, Biol. Nauki
Nauchnye Doklady Vysshei Shkoly, Biologicheskie Nauki *(U.S.S.R.)*

Nauchn.-Tekhn. Obshch. SSSR
Nauchno-Tekhnicheskie Obshchestva SSSR *(U.S.S.R.)*

Nauchn. Tr., Tashkentsk. Gos. Univ.
Nauchnye Trudy, Tashkentskii Gosudarstvennyi Universitet imeni V. I. Lenina *(Uzbek S.S.R.)*

Nauchn. Tr. Visshiya Med. Inst., Sofiya
Nauchni Trudov na Visshiya Meditsinski Institut, Sofiya *(Bulgaria)*

N. Carolina Med. J.
North Carolina Medical Journal, The *(U. S.)*

Nebraska State Med. J.
Nebraska State Medical Journal, The *(U. S.)*

NEC Res. Develop.
NEC Research and Development *(Japan)*

Ned. Tijdschr. Natuurk.
*Nederlands Tijdschrift voor Natuurkunde *(Netherlands)*

Neftekhimiya
Neftekhimiya *(U.S.S.R.)*

Nekotorye Vopr. Inzh. Fiz.
Nekotorye Voprosy Inzhenernoi Fiziki *(U.S.S.R.)*

Nektorye Vopr. Sovrem. Med., Sb.
Nektroye Voprosy Sovremennoi Meditsiny, Sbornik *(Azerbaidzhan S.S.R.)*

Neoplasma
*Neoplasma *(Czechoslovakia)*

Nepegeszseguay
Nepegeszseguay *(Hungary)*

Neue Huette
Neue Huette *(Germany)*

Neue Physik
*Neue Physik *(Austria)*

Neue Tech.
*Neue Technik *(Germany)*

Neurociruqia (Lima)
*Neurociruqia (Lima) *(Peru)*

Neurology
Neurology *(U. S.)*

New Engl. J. Med.
New England Journal of Medicine, The *(U. S.)*

Newer Metal Ind. (Tokyo)
Newer Metal Industry (Tokyo) *(Japan)*

New Physician
New Physician *(U. S.)*

New Scientist
*New Scientist, The *(England)*

New Zealand J. Geol. Geophys.
New Zealand Journal of Geology and Geophysics *(New Zealand)*

New Zealand J. Sci.
*New Zealand Journal of Science *(New Zealand)*

New Zealand Med. J.
New Zealand Medical Journal, The *(New Zealand)*

Niigata Daigaku Kogakubu Kenkyu Hokoku
Niigata Daigaku Kogakubu Kenkyu Hokoku (Research Reports of the Faculty of Engineering, Niigata University) *(Japan)*

Niigata Igakkai Zasshi
Niigata Igakkai Zasshi (Niigata Medical Journal) *(Japan)*

Niigata Med. J.
Niigata Medical Journal
see *Niigata Igakkai Zasshi*

Nippon Acta Radiol.
Nippon Acta Radiologica
see *Nippon Igaku Hoshasen Gakkai Zasshi*

Nippon Byorigakkai Kaishi
Nippon Byorigakkai Kaishi (Transactiones Soc. Pathologicae Japonicae) *(Japan)*

Nippon Eiseigaku Zasshi
Nippon Eiseigaku Zasshi (Japanese Journal of Hygiene) *(Japan)*

Nippon Ganka Gakkai Zasshi
Nippon Ganka Gakkai Zasshi (Acta Societatis Ophthalmologicae Japonicae) *(Japan)*

Nippon Genshiryoku Gakkaishi
*Nippon Genshiryoku Gakkaishi (Journal of the Atomic Energy Society of Japan) *(Japan)*

Nippon Gomu Kyokaishi
Nippon Gomu Kyokaishi (Journal of the Society of Rubber Industry of Japan) *(Japan)*

Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo
*Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo (Annual Report of the Japanese Association for Radiation Research on Polymers) *(Japan)*

Nippon Igaku Hoshasen Gakkai Zasshi
Nippon Igaku Hoshasen Gakkai Zasshi (Nippon Acta Radiologica) *(Japan)*

Nippon Iji Shimpo
Nippon Iji Shimpo (Japanese Medical Journal) *(Japan)*

Nippon Kagaku Zasshi
*Nippon Kagaku Zasshi (Journal of the Chemistry Society of Japan, Pure Chemistry Section) *(Japan)*

Nippon Ketsueki Gakkai Zasshi
Nippon Ketsueki Gakkai Zasshi (Acta Haematologica Japonica) *(Japan)*

Nippon Kikai Gakkai Rombunshu
Nippon Kikai Gakkai Rombunshu (Transactions of the Japan Society of Mechanical Engineers) *(Japan)*

Nippon Kikai Gakkai-shi
Nippon Kikai Gakkai-shi (Journal of the Japan Society of Mechanical Engineers) *(Japan)*

Nippon Kinzoku Gakkaishi
*Nippon Kinzoku Gakkaishi (Journal of the Japan Institute of Metals (Sendai)) *(Japan)*

Nippon Kogyo Kaishi
Nippon Kogyo Kaishi (Journal of the Mining and Metallurgical Institute of Japan) *(Japan)*

Nippon Kokan Giho
Nippon Kokan Giho (Nippon Kokan Technical Report) *(Japan)*

Nippon Kokan Tech. Rept.
Nippon Kokan Technical Report
see *Nippon Kokan Giho*

Nippon Nogeikagaku Kaishi
Nippon Nogeikagaku Kaishi (Journal of the Agricultural Chemical Society of Japan) *(Japan)*

Nippon Sanfujinka Zasshi
Nippon Sanfujinka Zasshi (Japanese edition of Journal of the Japanese Obstetrical and Gynecological Society) *(Japan)*

Nippon Sanshigaku Zasshi
Nippon Sanshigaku Zasshi (Journal of the Sericultural Science of Japan) *(Japan)*

Nippon Seirigaku Zasshi
Nippon Seirigaku Zasshi (Journal of the Physiological Society of Japan) *(Japan)*

Nippon Univ. J. Med.
Nippon University Journal of Medicine *(Japan)*

Nisshin Igaku
Nisshin Igaku (Japanese Journal of Medical Progress) *(Japan)*

Nord. Hyg. Tidskr.
Nordisk Hygienisk Tidskrift *(Denmark)*

Nord. Med.
Nordisk Medicin *(Norway)*

Norelco Reptr.
Norelco Reporter *(U. S.)*

Northwest Med.
Northwest Medicine *(U. S.)*

Notas Fis., Centro Brasil. Pesquisas Fis.
Notas de Fisica, Centro Brasileiro de Pesquisas Fisicas *(Brazil)*

Nouvelle Rev. Franc. Hematol.
Nouvelle Revue Francaise d'Hematologie *(France)*

Novenytermeles
Novenytermeles *(Hungary)*

Nowotwory
Nowotwory *(Poland)*

NTZ-Nachrtech. Z.
NTZ-Nachrichtentechnische Zeitschrift *(Germany)*

Nucl. Energy
*Nuclear Energy (formerly Nuclear Energy Engineer) *(England)*

Nucl. Eng.
*Nuclear Engineering incorporating Nuclear Power *(England)*

Nuclear Eng. (Tokyo)
Nuclear Engineering (Tokyo)
see **Genshiryoku Kogyo**

Nucleonics
*Nucleonics *(U. S.)*

Nucleus (Lahore)
Nucleus (Lahore) *(Pakistan)*

Nucleus (Paris)
*Nucleus. La Revue Scientifique a l'Age Atomique (Paris) *(France)*

Nucl. Fusion
*Nuclear Fusion (Journal of Plasma Physics and Thermonuclear Fusion *(Austria)*

Nucl. Hematol.
Nuclear Hematology (included in Nuclear Energy, paged separately) *(England)*

Nucl. Inform.
*Nuclear Information *(U. S.)*

Nucl. Instr. Methods
*Nuclear Instruments & Methods (formerly Nuclear Instruments) *(Netherlands)*

Nucl. Law Econ.
Nuclear Law and Economics *(Italy)*

Nucl.-Med.
*Nuclear-Medizin *(Germany)*

Nucl. News
*Nuclear News *(U. S.)*

Nucl. Phys.
*Nuclear Physics *(Netherlands)*

Nucl. Safety
*Nuclear Safety (A Quarterly Technical Progress Review) *(U. S.)*

Nucl. Sci. (Taiwan)
Nuclear Science (Taiwan) *(China)*
see **Ho Tzu K'o Hsueh**

Nucl. Sci. Abstr. Japan
*Nuclear Science Abstracts of Japan *(Japan)*

Nucl. Sci. Eng.
*Nuclear Science and Engineering *(U. S.)*

Nukl. Energija
Nuklearna Energija *(Yugoslavia)*

Nukleonik
*Nukleonik *(Germany)*

Nukleonika
*Nukleonika† *(Poland)*

Nuntius Radiol.
*Nuntius Radiologicus *(Italy)*

Nuova Giorn. Botan. Ital.
Nuova Giornale Botanico Italiano *(Italy)*

Nuovi Ann. Igiene Microbiol.
Nuovi Annali d'Igiene e Microbiologia *(Italy)*

Nuovo Cimento
*Nuovo Cimento (Including all supplements) *(Italy)*

Nursing Outlook
Nursing Outlook *(U. S.)*

Nutr. Rev.
Nutrition Reviews *(U. S.)*

N. Y. State Dental J.
New York State Dental Journal *(U. S.)*

N. Y. State J. Med.
New York State Journal of Medicine *(U. S.)*

Obstet. Gynecol.
Obstetrics and Gynecology *(U. S.)*

Ochrona Pracy
Ochrona Pracy *(Poland)*

Oeffentl. Gesundheitsdienst
Oeffentliche Gesundheitsdienst *(Germany)*

Oftal'mol. Zh.
Oftal'mologicheskii Zhurnal *(Ukrainian S.S.R.)*

Ogneupory
*Ogneupory† *(U.S.S.R.)*

Ohio Agr. Expt. Sta., Spec. Rept. Ser.
Ohio Agricultural Experiment Station, Special Report Series, *(U. S.)*

Ohio J. Sci.
Ohio Journal of Science, The *(U. S.)*

Oil Gas J.
Oil and Gas Journal, The *(U. S.)*

Okayama Daigaku Nogakubu Dojohiryogaku Hokoku
Okayama Daigaku Nogakubu Dojohiryogaku Hokoku (Report of the Laboratory of Soils and Fertilizers, Faculty of Agriculture, Okayama University) *(Japan)*

Okayama Igakkai Zasshi
*Okayama Igakkai Zasshi (Journal of the Okayama Medical Society) *(Japan)*

Okeanologiya
Okeanologiya *(U.S.S.R.)*

Oncologia
*Oncologia *(Switzerland)*

Onde Elec.
*Onde Electrique, L' *(France)*

Onken Kiyo
Onken Kiyo (The Bulletin of the Institute of Balneotherapeutics) *(Japan)*

Ontario Hydro Res. News
*Ontario Hydro Research News *(Canada)*

Ophthalmol. Ibero-Am.
*Ophthalmologia Ibero-Americana *(Brazil)*

Opt. i Spektroskopiya
Optika i Spektroskopiya† *(U.S.S.R.)*

Optometric Weekly
Optometric Weekly *(U. S.)*

Opt. Spectry. (USSR) (English Transl.)
*Optics and Spectroscopy (USSR) (English Translation of Optika i Spektroskopiya) *(U. S.)*

Oral Surg., Oral Med., Oral Pathol.
Oral Surgery, Oral Medicine, Oral Pathology *(U. S.)*

Orszagos Atomenergia Bizottsag Izotop Alkalm. Szakbizottsaganak Kiadv
Orszagos Atomenergia Bizottsag Izotop Alkalmazas Szakbizottsaganak Kiadv *(Hungary)*

Ortoped. Travmatol. i Protezirovan.
Ortopediya Travmatologiya i Protezirovaniya *(U.S.S.R.)*

Orv. Hetilap
Orvosi Hetilap *(Hungary)*

Osaka City Med. J.
*Osaka City Medical Journal *(Japan)*

Osaka Daigaku Igaku Zasshi
*Osaka Daigaku Igaku Zasshi (Medical Journal of Osaka University) *(Japan)*

Osaka Kogyo Gijutsu Shikenjo Kiho
Osaka Kogyo Gijutsu Shikensho Kiho (Bulletin of the Osaka Industrial Research Institute) *(Japan)*

Osaka Shiritsu Daigaku Igaku Zasshi
*Osaka Shiritsu Daigaku Igaku Zasshi (The Journal of the Osaka City Medical Center) *(Japan)*

Osped. Maggiore
Ospedale Maggiore, L' *(Italy)*

Oyo Butsuri
Oyo Butsuri (Journal of Applied Physics) *(Japan)*

Pakistan J. Sci. Ind. Res.
*Pakistan Journal of Scientific and Industrial Research *(Pakistan)*

Panminerva Med.
Panminerva Medica *(Italy)*

Papers Meteorol. Geophys. (Tokyo)
Papers in Meteorology and Geophysics (Tokyo) *(Japan)*

Pathol. Biol. Semaine Hop.
*Pathologie et Biologie, Archives de Biologie Medicale, Annales de la Recherche Medicale, La Semaine des Hopitaux *(France)*

Pathol. Microbiol.
Pathologia et Microbiologia *(Switzerland)*

Pathologica
*Pathologica *(Italy)*

Patol. Fiziol. i Eksperim. Terapiya
Patologicheskaya Fiziologiya i Eksperimental'naya Terapiya *(U.S.S.R.)*

Patol. Polska
Patologia Polska *(Poland)*

Pediat. Clin. North Am.
Pediatric Clinics of North America *(U. S.)*

Pediat. Pratica
*Pediatria Pratica *(Brazil)*

Pediatria (Santiago, Chile)
*Pediatria (Santiago, Chile) *(Chile)*

Pediatrics
Pediatrics *(U. S.)*

Pediatrie
Pediatrie *(France)*

Penn. Med. J.
Pennsylvania Medical Journal, The *(U. S.)*

Perspectives Biol. Med.
*Perspectives in Biology and Medicine *(U. S.)*

Pharm. Acta Helv.
Pharmaceutica Acta Helvetiae *(Switzerland)*
(Supplement to Schweizerische Apotheker-Zeitung)

Pharmazie
Pharmazie, Die *(Germany)*

Pharm. Tijdschr. Belg.
Pharmaceutisch Tijdschrift voor Belgie *(Belgium)*

Philippine Agriculturist
Philippine Agriculturist, The *(Philippines)*

Philippine J. Sci.
*Philippine Journal of Science *(Philippines)*

Philips Res. Rept.
*Philips Research Reports *(Netherlands)*

Philips Tech. Rev.
*Philips Technical Review *(Netherlands)*

Phil. Mag.
*Philosophical Magazine, The *(England)*

Phil. Trans. Roy. Soc. London, Ser. A.
Philosophical Transactions of the Royal Society of London, Series A *(England)*

Phil. Trans. Roy. Soc. London, Ser. B.
Philosophical Transactions of the Royal Society of London, Series B *(England)*

Photochem. Photobiol.
Photochemistry and Photobiology *(England)*

Phot. Sci. Eng.
*Photographic Science and Engineering *(U. S.)*

Phot. Wiss.
Photographie und Wissenschaft *(Germany)*

Phys. Can.
*Physics in Canada *(Canada)*

Phys. Chem. Glasses
Physics and Chemistry of Glasses *(England)*

Phys. Chem. Solids
Physics and Chemistry of Solids, The *(U. S.)*

Phys. Fluids
*Physics of Fluids, The *(U. S.)*

Physica
*Physica *(Netherlands)*

Physics
*Physics *(U. S.)*

Physik. Bl.
Physikalische Blaetter *(Germany)*

Physik Kondensierten Materie
*Physik der Kondensierten Materie *(Germany)*

Physiol. Bohemoslov.
Physiologia Bohemoslovenica *(Czechoslovakia)*

Physiol. Plantarum
Physiologia Plantarum *(Denmark)*

Phys. Letters
*Physics Letters *(Netherlands)*

Phys. Math. Univ. Oslo. Inst. Dept.
Physica Mathematica Universitatis Osloensis. Institute Report *(Norway)*

Phys. Med. Biol.
*Physics in Medicine and Biology *(England)*

Phys. Norvegica
*Physica Norvegica *(Norway)*

Phys. Rev.
*Physical Review, The *(U. S.)*

Phys. Rev. Letters
*Physical Review Letters *(U. S.)*

Phys. Status Solidi
*Physica Status Solidi *(Germany)*

Phys. Today
*Physics Today *(U. S.)*

Phytopathology
Phytopathology *(U. S.)*

Planetary Space Sci.
*Planetary and Space Science *(England)*

Planseeber. Pulvermet.
*Planseeberichte fuer Pulvermetallurgie Vereinigt mit Powder Metallurgy Bulletin *(Austria)*

Planta
Planta *(Germany)*

Plant Physiol.
*Plant Physiology *(U. S.)*

Plasma Phys.-Accelerators-Thermonucl. Res., J. Nucl. Energy: Pt. C
Plasma Physics-Accelerators-Thermonuclear Research, Journal of Nuclear Energy: Part C
see *J. Nucl. Energy: Pt. C*

Plasticheskie Massy
Plasticheskie Massy† *(U.S.S.R.)*

Plastic Reconstruct. Surg.
Plastic and Reconstructive Surgery and the Transplantation Bulletin *(U. S.)*

Plastics (London)
Plastics (London) *(England)*

Platina
Platina *(U. S.)*

Platinum Metals Rev.
Platinum Metals Review *(England)*

Pochvovedenie
Pochvovedenie† *(U.S.S.R.)*

Policlinico (Rome), Sez. Prat.
Policlinico, Il (Rome), Sezione Pratica *(Italy)*

Polish Med. J.
Polish Medical Journal *(Poland)*

Polskie Arch. Med. Wewnetrznej
*Polskie Archiwum Medycyny Wewnetrznej *(Poland)*

Polski Przegląd Radiol. i Med. Nuklearnej
*Polski Przegląd Radiologii i Medycyny Nuklearnej *(Poland)*

Polski Tygod. Lekar.
Polski Tygodnik Lekarski *(Poland)*

Polski Tygod. Lekar. Wiadomości. Lekar.
Polski Tygodnik Lekarski i Wiadomości Lekarskie *(Poland)*

Polymer
*Polymer *(England)*

Polytech. Tijdschr.
Polytechnisch Tijdschrift *(Netherlands)*

Poroshkovaya Met., Akad. Nauk Ukr. SSR
*Poroshkovaya Metallurgiya, Akademiya Nauk Ukrainskoi SSR *(Ukrainian S.S.R.)*

Postepy Astron.
Postepy Astronomii *(Poland)*

Postepy Biochem.
*Postepy Biochemii *(Poland)*

Postepy Fiz.
*Postepy Fizyki *(Poland)*

Postepy Hig. Med. Doswiadczalnej
*Postepy Higieny i Medycyny Doswiadczalnej *(Poland)*

Postepy Nauk Rolniczych
*Postepy Nauk Rolniczych *(Poland)*

Postgrad. Med.
Postgraduate Medicine *(U. S.)*

Poultry Sci.
Poultry Science *(U. S.)*

Powder Met.
*Powder Metallurgy *(England)*

Power Express
Power Express *(U. S.)*

Power Reactor Technol.
*Power Reactor Technology (A Quarterly Technical Progress Review) *(U. S.)*

Prace Central. Inst. Ochrony Pracy
Prace Centralnego Instytutu Ochrony Pracy *(Poland)*

Prace Inst. Hutniczych
*Prace Instytutow Hutniczych *(Poland)*

Pracovni Lekar.
*Pracovni Lekarstvi *(Czechoslovakia)*

Practitioner
Practitioner, The *(England)*

Prakt. Energiek.
Praktische Energiekunde *(Germany)*

Praxis (Bern)
Praxis (Bern) *(Switzerland)*

Precambrian
*Precambrian *(Canada)*

Precision Metal Molding
Precision Metal Molding *(U. S.)*

Prensa Med. Arg.
Prensa Medica Argentina, La *(Argentina)*

Presbyterian-St. Luke's Hosp. Med. Bull.
*Presbyterian-St. Luke's Hospital Medical Bulletin *(U. S.)*

Presse Med.
Presse Medicale, La *(France)*

Pribory i Tekhn. Eksperim.
*Pribory i Tekhnika Eksperimenta† *(U.S.S.R.)*

Prikl. Mat. i Mekhan.
*Prikladnaya Matematika i Mekhanika† *(U.S.S.R.)*

Primena Radioaktiv. Izotopa i Jonizujucih Zracenja u Med.
*Primena Radioaktivnih Izotopa i Jonizujucih Zracenja u Medicini *(Yugoslavia)*

Primenenie Tsirkoniya i ego Soedin. v Prom. Akad. Nauk Ukr. SSR, Inst. Obshch. i Neorgan. Khim., Materialy Soveshch., Kiev (1960)
Primenenie Tsirkoniya i ego Soedinenii v Promyshlennosti, Akademiya Nauk Ukrainskoi SSR, Institut Obshchei i Neorganicheskoi Khimii, Materialy Soveshchaniya, Kiev, June 15-18, 1960 (Pub. 1962) *(Ukrainian S.S.R.)*

Priroda
*Priroda *(U.S.S.R.)*

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Radiologe
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Radiology
*Radiology *(U. S.)*
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Radiotekhn. i Elektron.
*Radiotekhnika i Elektronika† *(U.S.S.R.)*
Radovi Med. Fak. Zagrebu
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Rass. Dermatol. Sifilog.
Rasseana di Dermatologia e di Sifilografia *(Italy)*
Rass. Med. Ind.
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Razved. i Promysl. Geofiz., Vses. Nauchn.-Issled. Inst. Geofiz. Metodov Razvedki
Razvedochnaya i Promyslovaya Geofizika, Vsesoyuznyi Nauchno-Issledovatel'skii Institut Geofizicheskikh Metodov Razvedki *(U.S.S.R.)*
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Rendiconti
Rendiconti *(Italy)*
Rend. Ist. Sci. Univ. Camerino
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*Revue de Physique, Academie de la Republique Populaire Roumaine *(Romania)*

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Rev. Port. Quim. (Lisbon)
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Rev. Soudure (Brussels)
Revue de la Soudure (Brussels) *(Belgium)*
Rev. Tuberc. (Paris)
Revue de la Tuberculose (Paris) *(France)*
Rev. Union Mat. Arg. Asoc. Fis. Arg.
*Revista de la Union Matematica Argentina y de la Asociacion Fisica Argentina *(Argentina)*
Rev. Universelle Mines
Revue Universelle des Mines de la Metallurgie, de la Mecanique, des Travaux Publics, des Sciences et des Arts Appliques a l'Industrie *(Belgium)*
Rev. Univ. Ind. Santander
*Revista de la Universidad Industrial de Santander *(Colombia)*
Rev. Urol. (Caracas)
*Revista de Urologia (Caracas) *(Venezuela)*
Rev. Urol. (Mex.)
*Revista de Urologia *(Mexico)*
Rev. Venezolana Urol.
Revista Venezolana de Urologia *(Venezuela)*
Rheumatism
*Rheumatism *(England)*
Ric. Sci. Rend., Sez. A
*Ricerca Scientifica, La. Parte 2: Rendiconti, Sezione A, Abiologica *(Italy)*
Ric. Sci. Rend., Sez. B
*Ricerca Scientifica, La. Parte 2: Rendiconti, Sezione B, Biologica *(Italy)*
Rika Gaku Kenkyusho Hokoku
*Rika Gaku Kenkyusho Hokoku (Reports of the Institute of Physical and Chemical Research) *(Japan)*
Rinsho Ganka
Rinsho Ganka (Journal of Clinical Ophthalmology) *(Japan)*
Rinsho Geka
Rinsho Geka (Clinical Surgery) *(Japan)*
Rinsho Hoshasen
Rinsho Hoshasen (Clinical Radiology) *(Japan)*
Riv. Biol.
*Rivista di Biologia (Pubblicata a Cura dell'Istituto di Biologia Generale dell'Universita di Perugia) *(Italy)*
Riv. Clin. Pediat.
*Rivista di Clinica Pediatrica *(Italy)*
Riv. Ing.
Rivista di Ingegneria *(Italy)*
Riv. Ing. Nucl
*Rivista di Ingegneria Nucleare *(Italy)*
Riv. Ist. Sieroterap. Ital.
*Rivista dell'Istituto Sieroterapico Italiano *(Italy)*
Riv. Ital. Igiene
Rivista Italiana d'Igiene *(Italy)*
Riv. Med. Aeron. Spaziale
Rivista di Medicina Aeronautica e Spaziale *(Italy)*
Riv. Meteorol. Aeronaut.
Rivista di Meteorologia Aeronautica *(Italy)*
Rivoluzione Ind.
*Rivoluzione Industriale *(Italy)*
Riv. Ostet. Ginecol.
Rivista di Ostetricia e Ginecologia *(Italy)*
Riv. Patol. Clin.
Rivista di Patologia e Clinica *(Italy)*
Riv. Radiol.
Rivista de Radiologia *(Italy)*
Rocky Mt. Med. J.
Rocky Mountain Medical Journal *(U. S.)*
Roczniki Chem.
*Roczniki Chemii *(Poland)*
Roczniki Nauk Rolniczych, Ser. A
Roczniki Nauk Rolniczych, Seria A *(Poland)*
Roczniki Panstwowego Zakladu Hig.
*Roczniki Panstwowego Zakladu Higieny *(Poland)*
Roentgen Bl.
Roentgen Blaetter *(Germany)*
Roentgen-Lab. Praxis
Roentgen- und Laboratoriums Praxis *(Germany)*
Rozhledy Tuberk.
Rozhledy v Tuberkulose a Nemocech Plicnich *(Czechoslovakia)*
Rozpravy Cesk. Akad. Ved, Rada Mat. Prirod. Ved
Rozpravy Ceskoslovenske Akademie Ved, Rada Matematickych a Prirodnich Ved *(Czechoslovakia)*
Rozprawy Elektrotech.
*Rozprawy Elektrotechniczne *(Poland)*
RTD Technol. Briefs
RTD Technology Briefs *(U. S.)*
RTVA, Rev. Tech. Vet. Abattoirs
RTVA, Revue Techniaue Veterinaire des Abattoirs et d'Hygiene Alimentaire *(France)*
Rubber Age (N. Y.)
Rubber Age, The (New York) *(U. S.)*
Rudarsko-Met. Zbornik
Rudarsko-Metalurski Zbornik *(Yugoslavia)*
Rudy Metale Niezelazne
*Rudy i Metale Niezelazne *(Poland)*
Rumanian Med. Rev.
*Rumanian Medical Review *(Romania)*
Rybn. Khozv.
Rybnoe Khozvaistvo *(U.S.S.R.)*
S.A.E. Journal
S.A.E. Journal *(U. S.)*
S. African Ind. Chemist
South African Industrial Chemist, The *(S. Africa)*
S. African J. Agr. Sci.
South African Journal of Aaricultural Science *(S. Africa)*
S. African J. Lab. Clin. Med.
South African Journal of Laboratory and Clinical Medicine *(S. Africa)*
S. African J. Radiol.
*South African Journal of Radiology *(S. Africa)*
S. African J. Sci.
South African Journal of Science *(Union of S. Africa)*
S. African Mech. Engr.
South African Mechanical Engineer, The *(Union of S. Africa)*
S. African Med. J.
South African Medical Journal *(Union of S. Africa)*
Saiko To Hoan
Saiko To Hoan (Mining and Safety) *(Japan)*
Sangyo Igaku
Sangyo Igaku (Japanese Journal of Industrial Health) *(Japan)*
Sanitarian (London)
Sanitarian (London) *(England)*
Sanitarian's J. Environ. Health
Sanitarian's Journal of Environmental Health, The *(U. S.)*
Santo Tomas J. Med.
*Santo Tomas Journal of Medicine *(Philippines)*
Sb. Lekar.
Sbornik Lekarsky *(Czechoslovakia)*
Sb. Nauchn. Rabot Nauchn.-Issled. Rentgeno-Radiol. Inst. Azerb. SSR
Sbornik Nauchnykh Rabot Nauchno-Issledovatel'skogo Rentgeno-Radiologicheskogo Instituta Azerbaidzhanskoi SSR *(Azerbaidzhan S.S.R.)*
Sb. Nauchn. Tr. Inst. Metallofiz., Akad. Nauk Ukr. SSR
*Sbornik Nauchnykh Trudov Instituta Metallofiziki, Akademiya Nauk Ukrainskoi SSR (formerly Sbornik Nauchnykh Rabot Instituta Metallofiziki, Akademiya Nauk Ukrainskoi SSR) *(Ukrainian S.S.R.)*
Sb. Nauchn. Tr. Nauchn. Issled. Inst. Rentgenol., Radiol. i Onkol., Uz. SSR
Sbornik Nauchnykh Trudov Nauchno-Issledovatel'skogo Instituta Rentgenologii, Radiologii, i Onkologii, Uzbekskaya SSR *(Uzbek S.S.R.)*
Sb. Nauchn. Tr. Tashkentsk. Gos. Med. Inst.
Sbornik Nauchnykh Trudov Tashkentskogo Gosudarstvennogo Meditsinskogo Institut *(Uzbek S.S.R.)*
Sb. Rabot po Nekotorym Vopr. Dozimetr. i Radiometr. Ionizir. Izluchenii
Sbornik Rabot po Nekotorym Voprosma Dozimetrii i Radiometrii Ioniziruyushchika Izluchenii *(U.S.S.R.)*
Sb. Tr. po Agron. Fiz., Vses. Akad. Sel'skokhoz. Nauk
Sbornik Trudov po Agronomicheskoi Fizike, Vsesoyuznaya Akademiya Sel'skokhozvaistvennykh Nauk imeni V. I. Lenina *(U.S.S.R.)*
Sb. Tr. Sverdlovsk. Gos. Med. Inst.
Sbornik Trudov Sverdlovskogo Gosudarstvennogo Meditsinskogo Instituta *(U.S.S.R.)*
Sb. Ved. Praci Lekar. Fak. Karlovy Univ. Hradci Kralove
*Sbornik Vedeckych Praci Lekarske Fakulty Karlovy University v Hradci Kralove *(Czechoslovakia)*
Scalpel
Scalpel, Le *(Belgium)*

Scand. J. Clin. Lab. Invest.
Scandinavian Journal of Clinical & Laboratory Investigation *(Denmark)*

Scand. J. Haematol.
*Scandinavian Journal of Haematology *(Denmark)*

Schriftenreihe Bundesmin. Atomkernenergie Wasserwirtsch. (Munich)
*Schriftenreihe des Bundesministers fuer Atomkernenergie und Wasserwirtschaft (Munich) *(Germany)*

Schriftenreihe Bundesmin. Wiss. Forsch., Strahlenschutz (Munich)
*Schriftenreihe des Bundesministers fuer Wissenschaftliche Forschung, Strahlenschutz (Munich) *(Germany)*

Schweiz. Arch. Angew. Wiss. Tech.
*Schweizer Archiv fuer Angewandte Wissenschaft und Technik *(Switzerland)*

Schweiz. Med. Wochschr.
Schweizerische Medizinische Wochenschrift *(Switzerland)*

Schweiz. Tech. Z.
Schweizerische Technische Zeitschrift *(Switzerland)*

Schweiz. Ver. Atomenergie, Bull.
Schweizerische Vereinigung fuer Atomenergie, Bulletin *(Switzerland)*

Sci. Am.
*Scientific American *(U. S.)*

Sci. Cult. (Calcutta)
Science and Culture (Calcutta) *(India)*

Science
*Science *(U. S.)*

Science (Tokyo)
Science (Tokyo)
see Kagaku (Tokyo)

Scientia
Scientia
see K'o Hsueh T'ung Pao

Scientia (Valparaiso, Chile)
*Scientia (Valparaiso, Chile) *(Chile)*

Scientiae
*Scientiae *(South Africa)*

Scientist Citizen
Scientist and Citizen (formerly Nuclear Information) *(U. S.)*

Sci., Gen. Rept.
Science, General Reports
see Kexue Tongbao

Sci. Ind. Phot.
Science et Industries Photographiques *(France)*

Sci. Papers Coll. Gen. Educ., Univ. Tokyo
*Scientific Papers of the College of General Education, University of Tokyo *(Japan)*

Sci. Papers Inst. Phys. Chem. Res. (Tokyo)
*Scientific Papers of the Institute of Physical and Chemical Research (Tokyo) (formerly Journal of the Scientific Research Institute (Tokyo)) *(Japan)*

Sci. Progr. (London)
*Science Progress (London) *(England)*

Sci. Progr.-Nature
*Science Progres--La Nature *(France)*

Sci. Rept. Fac. Lit. Sci., Hirosaki Univ.
Science Reports of the Faculty of Literature and Science, Hirosaki University *(Japan)*

Sci. Rept. Ist. Super Sanita
Scientific Reports of the Istituto Superiore di Sanita (formerly Selected Scientific Papers from the Istituto Superiore di Sanita) *(Netherlands)*

Sci. Rept. Res. Inst. Theoret. Phys., Hiroshima Univ.
*Scientific Reports of the Research Institute for Theoretical Physics, Hiroshima University *(Japan)*

Sci. Rept. Res. Inst., Tohoku Univ., Ser. A
*Scientific Reports of the Research Institutes, The, Tohoku University, Series A *(Japan)*

Sci. Rept. Saitama Univ., Ser. A
*Science Reports of Saitama University, The, Series A *(Japan)*

Sci. Rept. Shiga Prefectural Junior Coll.
Scientific Reports of Shiga Prefectural Junior College
see Shigakenritsu Tanki Daigaku Gakijutsu Zasshi

Sci. Rev. (Manila)
Science Review (Manila) *(Philippines)*

Sci. Sinica (Peking)
*Scientia Sinica (Peking) *(China)*

Scottish Eng. Students' Assoc. J.
Scottish Engineering Students' Association Journal *(Scotland)*

Scripta Med. Fac. Med. Univ. Brun. Olomuc.
Scripta Medica Facultatum Medicinae Universitatum Brunensis et Olomucencis *(Czechoslovakia)*

Seiken Jiho
Seiken Jiho (Reports of the Kihara Inst. for Biological Research) *(Japan)*

Semaine Hop. Paris
Semaine des Hopitaux de Paris, La *(France)*

Semana Med. (Buenos Aires)
Semana Medica, La (Buenos Aires) *(Argentina)*

Semento Konkuriito
Semento Konkuriito (Cement and Concrete) *(Japan)*

Semicond. Prod.
Semiconductor Products *(U. S.)*

Seni-i Gakkaishi
Seni-i Gakkaishi (Journal of the Society of Textile and Cellulose Industries, Japan) *(Japan)*

Senshokutai
Senshokutai (Kromosoma, La) *(Japan)*

Sheet Metal Ind.
Sheet Metal Industries incorporating Press Tool Engineering *(England)*

Sheng Li Hsueh Pao
Sheng Li Hsueh Pao (Acta Physiologica Sinica) *(China)*

Sheng Wu Hua Hsueh Yu Shing Wu Wu Li Hsueh Pao
Sheng Wu Hua Hsueh Yu Shing Wu Wu Li Hsueh Pao (Acta Biochimica et Biophysica Sinica) *(China)*

Shigakenritsu Tanki Daigaku Gakijutsu Zasshi
Shigakenritsu Tanki Daigaku Gakijutsu Zasshi (Scientific Reports of Shiga Prefectural Junior College) *(Japan)*

Shih Yen Sheng Wu Hsueh Pao
Shih Yen Sheng Wu Hsueh Pao (Acta Biologiae Experimentalis Sinica) *(China)*

Shika Zairyo Kenkyusho Hokoku
Shika Zairyo Kenkyusho Hokoku (Report of the Research Institute of Dental Materials, Tokyo Medical and Dental University) *(Japan)*

Shikoku Acta Med.
Shikoku Acta Medica
see Shikoku Igaku Zasshi

Shikoku Igaku Zasshi
*Shikoku Igaku Zasshi (Shikoku Acta Medica) *(Japan)*

Shinku
Shinku (Journal of the Vacuum Society of Japan) *(Japan)*

Shipbuilder Marine Engine-Builder
Shipbuilder and Marine Engine-Builder, The *(England)*

Shipping (Tokyo)
Shipping (Tokyo) *(Japan)*

Shitsuryo Bunseki
Shitsuryo Bunseki (Mass Spectroscopy (Tokyo)) *(Japan)*

Shizen
Shizen (Nature (Tokyo)) *(Japan)*

Showa Igakukai Zasshi
Showa Igakukai Zasshi (The Journal of the Showa Medical Association) *(Japan)*

SIAM (Soc. Ind. Appl. Math.) Rev.
*SIAM (Society for Industrial and Applied Mathematics) Review *(U. S.)*

Siemens Rev.
Siemens Review *(Germany)*

Silicates Ind.
Silicates Industriels *(Belgium)*

Simon Stevin. Wis- Natuurk. Tijdschr.
Simon Stevin. Wis- en Natuurkundig Tijdschrift *(Netherlands)*

Singapore Med. J.
Singapore Medical Journal *(Malaya)*

Sitzber. Ges. Befoerder. Ges. Naturw. Marburg
Sitzungsberichte der Gesellschaft zur Befoerderung der Gesamten Naturwissenschaften zu Marburg *(Germany)*

Sitzber. Math. Naturw. Kl. Bayer. Akad. Wiss. Muenchen
*Sitzungsberichte der Mathematisch-Naturwissenschaftlichen Klasse der Bayerischen Akademie der Wissenschaften zu Muenchen *(Germany)*

Sky Telescope
Sky and Telescope *(U. S.)*

Slaboproudy Obzor
Slaboproudy Obzor *(Czechoslovakia)*

Smithsonian Contrib. Astrophys.
Smithsonian Contributions to Astrophysics *(U. S.)*

Soc. Sci. Fennica, Commentationes Phys.-Math.
*Societas Scientiarum Fennica, Commentationes Physico-Mathematicae *(Finland)*

Soao Iaaku
Soao Iaaku (Medicine) *(Japan)*
Soao-Kaivokaaaku
Soao-Kaivokaaaku (Bulletin of Marine Science) *(Japan)*
Soao Rinsho
Soao Rinsho (Clinics All-round (Osaka)) *(Japan)*
Soil Sci.
*Soil Science *(U. S.)*
Soil Sci. Soc. Am., Proc.
*Soil Science Society of America, Proceedings *(U. S.)*
Solid State Commun.
*Solid State Communications *(U. S.)*
Soobshch. Akad. Nauk Gruz. SSR
Soobshcheniya Akademii Nauk Gruzinskoi SSR *(Georgian S.S.R.)*
Soobshch. Lab. Agrokhim., Akad. Nauk Arm. SSR
Soobshcheniya Laboratorii Agrokhimii, Akademiya Nauk Armyanskoi SSR *(Armenian S.S.R.)*
Sorvushiron Kenkyu
Sorvushiron Kenkyu (Study of Elementary Particles) *(Japan)*
Soudage Tech. Connexes
Soundage et Techniques Connexes *(France)*
Southern Med. J.
Southern Medical Journal *(U. S.)*
Soviet Astron. AJ (English Transl.)
*Soviet Astronomy–AJ (English Translation of Astronomicheskii Zhurnal) *(U. S.)*
Soviet Phys.–Cryst. (English Transl.)
*Soviet Physics–Crystallography (English Translation of Kristallografiya) *(U. S.)*
Soviet Phys.-Solid State (English Transl.)
*Soviet Physics–Solid State (English translation of Fizika Tverdogo Tela) *(U. S.)*
Soviet Powder Met. Metal Ceram. (English Transl.)
Soviet Powder Metallurgy and Metal Ceramics (English Translation of Poroshkovaya Metallurgiya, Akademiya Nauk Ukrainskoi SSR) *(U. S.)*
Sowjetwiss.; Naturw. Beitr.
Sowjetwissenschaft; Naturwissenschaftliche Beitraege *(Germany)*
Space/Aeron.
Space/Aeronautics *(U. S.)*
Space Sci. Rev.
*Space Science Reviews *(Netherlands)*
Spectrochim. Acta
*Spectrochimica Acta *(England)*
Spektral'n. Opred. Redkikh i Rasseyan. Elementov, Akad. Nauk SSSR, Inst. Geokhim. i Analit. Khim.
Spektral'noe Opredelenie Redkikh i Rasseyannykh Elementov, Akademiya Nauk SSSR Institut Geokhimii i Analiticheskoi Khimii imeni V. I. Vernadskogo *(U.S.S.R.)*
Sperimentale
*Sperimentale, Lo *(Italy)*
SPE (Soc. Plastics Engrs.) Trans.
SPE (Society of Plastics Engineers) Transactions *(U. S.)*
Sprechsaal
Sprechsaal fuer Keramik-Glas-Email *(Germany)*
SRW News
SRW News (Siemens-Reiniger-Werke) *(Germany)*
Stahl Eisen
Stahl und Eisen *(Germany)*
Stain Technol.
Stain Technology *(U. S.)*
Stal
Stal' *(U.S.S.R.)*
Stanford Med. Bull.
Stanford Medical Bulletin *(U. S.)*
Staub
*Staub *(Germany)*
Steel
Steel *(U. S.)*
Steklo i Keram.
Steklo i Keramika *(U.S.S.R.)*
Steroids
Steriods *(U. S.)*
Strahlentherapie
*Strahlentherapie *(Germany)*
Strahlentherapie, Sonderbaende
*Strahlentherapie, Sonderbaende *(Germany)*
Strasboura Med.
Strasboura Medical *(France)*
Studia Math.
*Studia Mathematica *(Poland)*
Studia Univ. Babes-Bolyai, Ser. Chem.
*Studia Universitatis Babes-Bolyai, Series Chemia *(Romania)*
Studia Univ. Babes-Bolyai, Ser. Math.-Phys.
*Studia Universitatis Babes-Bolyai, Series Mathematica-Physica *(Romania)*
Studii Cercetari Med. Interna
Studii si Cercetari de Medicina Interna *(Romania)*
Study Elem. Particles (Japan)
Study of Elementary Particles (Japan)
see **Sorvushiron Kenkyu**
Sudebno-Med. Ekspertiza, Min. Zdravookhr. SSSR
Sudebno-Meditsinskaya Ekspertiza, Ministerstvo Zdravookhraneniya SSSR *(U.S.S.R.)*
Suisse Horlogere
Suisse Horlogere et Revue Internationale de l'Horlogerie *(Switzerland)*
Sulzer Tech. Rev. (Switz.)
*Sulzer Technical Review *(Switzerland)*
Sumitomo Denki
Sumitomo Denki (Sumitomo Electric Review) *(Japan)*
Sumitomo Elec. Rev.
Sumitomo Electric Review
see **Sumitomo Denki**
Sum. Shute Inst. Clin. Lab. Med.
Summary from the Shute Institute for Clinical and Laboratory Medicine *(Canada)*
Suomen Kemistilehti, A
*Suomen Kemistilehti, Section A *(Finland)*
Suomen Kemistilehti, B
*Suomen Kemistilehti, Section B *(Finland)*
Suomen Laakarilehti
Suomen Laakarilehti *(Finland)*
Surg. Clin. North Am.
Surgical Clinics of North America, The *(U. S.)*
Surgery
Surgery *(U. S.)*
Surg. Forum
Surgical Forum *(U. S.)*
Surg., Gynaecol. Obstet.
Surgery, Gynecology and Obstetrics with International Abstracts of Surgery *(U. S.)*
Svarka Tsvetn. Metal. i Splavov, Sb. Statei
Svarka Tsvetnykh Metallov i Splavov, Sbornik Statei *(U.S.S.R.)*
Svarochn. Proizv.
Svarochnoe Proizvodstvo *(U.S.S.R.)*
Svenska Lakartidn.
Svenska Lakartidningen *(Sweden)*
Svensk Kem. Tidskr.
*Svensk Kemisk Tidskrift *(Sweden)*
Symp. Tech. Zagadnien Ochrony Promieniowaniem, Warsaw, 1962
Sympozjum na Temat Technicznych Zagadnien Ochrony przed Promieniowaniem, Warsaw, September 1962 *(Poland)*
Taiki Hoshano Kansoku Seiseki
*Taiki Hoshano Kansoku Seiseki (Bulletin of the Atmospheric Radioactivity) *(Japan)*
T'ai-wan I Hsueh Hui Tsa Chih
T'ai-wan I Hsueh Hui Tsa Chih (Journal of the Formosan Medical Association) *(China)*
Talanta
*Talanta *(England)*
Tech. Dig. (Prague)
Technical Digest. A Monthly Review of Technology and Science in Socialist Countries (Prague) *(Czechoslovakia)*
Tech. Mitt. Krupp. Forschungsber.
*Technische Mitteilungen Krupp. Forschungsberichte *(Germany)*
Tech. Mod.
Technique Moderne; Revue Universelle des Sciences Appliquees a l'Industrie *(France)*
Tech. News Bull. (Gen. Precision Aerospace)
Technical News Bulletin (General Precision Aerospace) *(U. S.)*
Technik (Berlin)
Technik, Die (Berlin) *(Germany)*
Technol. Rept. Osaka Univ.
Technology Reports of the Osaka University *(Japan)*
Tech. Rept. Eng. Res. Inst., Kyoto Univ.
*Technical Reports of the Engineering Research Institute, Kyoto University *(Japan)*

Tech. Rev., Mitsubishi Nippon Heavy-Ind.
Technical Review, Mitsubishi Nippon Heavy-Industries
see ***Mitsubishi Nippon Juko Giho***

Tech. Sci. Munic.
Techniques et Sciences Municipales *(France)*

Tech. Ueberwach.
*Technische Ueberwachung *(Germany)*

Tec. Ital.
Tecnica Italiana *(Italy)*

Tehnika (Belgrade)
Tehnika (Belgrade) *(Yugoslavia)*

Teion Kagaku, B
Teion Kagaku, B (Low Temperature Science, Series B, Biological Science) *(Japan)*

Tekhn. i Vooruzhenie
Tekhnika i Vooruzhenie *(U.S.S.R.)*

Tekhn. Molodezhi
Tekhnika Molodezhi *(U.S.S.R.)*

Tek. Tidskr.
Teknisk Tidskrift *(Sweden)*

Telefunken Ztg.
*Telefunken Zeitung *(Germany)*

Teleteknik (English Ed.)
*Teleteknik (English Edition) *(Denmark)*

Tellus
*Tellus, A Quarterly Journal of Geophysics *(Sweden)*

Teploenergetika
*Teploenergetika *(U.S.S.R.)*

Teplofiz. Vysokikh Temp.
Teplofizika Vysokikh Temperatur† *(U.S.S.R.)*

Termotecnica (Milan)
Termotecnica, La (Milan) *(Italy)*

Tetrahedron
*Tetrahedron *(Northern Ireland)*

Tetrahedron Letters
Tetrahedron Letters *(Northern Ireland)*

Tetsu To Hagane
Tetsu To Hagane (Journal of the Iron and Steel Institute) *(U. S.-Japan)*

Texas J. Sci.
Texas Journal of Science, The *(U. S.)*

Texas Rept. Biol. Med.
*Texas Reports on Biology and Medicine *(U. S.)*

Texas State J. Med.
Texas State Journal of Medicine *(U. S.)*

Textile Res. J.
Textile Research Journal *(U. S.)*

Therapie Gegenwart
Therapie der Gegenwart *(Germany)*

Therapie Monats
Therapie des Monats *(Germany)*

Therap., Semaine Hop.
Therapeutique, La Semaine des Hopitaux *(France)*

Therap. Umschau
Therapeutische Umschau und Medizinische Bibliographie *(Switzerland)*

Thermal Power (Japan)
Thermal Power (Japan), The
see ***Karyoku Hatsuden***

Theses Chonnam Univ.
Theses of Chonnam University *(Korea)*

Thorax
Thorax *(England)*

Thromb. Diath. Haemorrhag.
Thrombosis et Diathesis Haemorrhagica *(Germany)*

Ti Ch'iu Wu Li Hsueh Pao
Ti Ch'iu Wu Li Hsueh Pao (Acta Geophysica Sinica) *(China)*

Tidskr. Mil. Halsovard
Tidskrift i Militar Halsovard *(Sweden)*

Tidsskr. Kjemi, Beravesen Met.
*Tidsskrift for Kjemi, Beravesen og Metallurgi *(Norway)*

Tidsskr. Norske Laegeforen.
Tidsskrift for den Norske Laegeforening *(Norway)*

Tijdschr. Sociale Geneesk.
Tijdschrift voor Sociale Geneeskunde *(Netherlands)*

Tohoku Igaku Zasshi
Tohoku Igaku Zasshi (Tohoku Medical Journal) *(Japan)*

Tohoku J. Exptl. Med.
*Tohoku Journal of Experimental Medicine, The *(Japan)*

Tohoku Med. J.
Tohoku Medical Journal
see ***Tohoku Igaku Zasshi***

Tokushima J. Exptl. Med.
*Tokushima Journal of Experimental Medicine, The *(Japan)*

Tokyo Daigaku Koku Kenkyusho Shuho
Tokyo Daigaku Koku Kenkyusho Shusho (Bulletin of the Aeronautical Research Institute, University of Tokyo) *(Japan)*

Tokyo Daigaku Seisan Gijutsu Kenkyusho Hokoku
*Tokyo Daigaku Seisan Gijutsu Kenkyusho Hokoku (Report of the Institute of Industrial Science, University of Tokyo) *(Japan)*

Tokyo Kogyo Shikensho Hokoku
*Tokyo Kogyo Shikensho Hokoku (Reports of the Government Chemical Industrial Research Institute, Tokyo) *(Japan)*

Tokyo-to Ritsu Kogyo Shoreikan Hokoku
Tokyo-to Ritsu Kogyo Shoreikan Hokoku (Reports of Tokyo Metropolitan Industrial Research Institute) *(Japan)*

Torax
*Torax *(Uruguay)*

Toshiba Rev., Intern. Ed.
*Toshiba Review, International Edition *(Japan)*

Toxicol. App. Pharmacol.
Toxicology and Applied Pharmacology *(U. S.)*

Toxicon
Toxicon *(U. S.)*

Trade Ind.
Trade and Industry *(Pakistan)*

Trans. AIME, Met. Soc.
Transactions of AIME, Metallurgical Society
see ***Trans. Met. Soc. AIME***

Trans. Am. Acad. Ophthalmol. Otolaryngol.
Transactions of the American Academy of Ophthalmology and Otolaryngology *(U. S.)*

Trans. Am. Foundrymen's Soc.
Transactions of the American Foundrymen's Society *(U. S.)*

Trans. Am. Geophys. Union
*Transactions of the American Geophysical Union *(U. S.)*

Trans. Am. Neurol. Assoc.
Transactions of the American Neurological Association *(U. S.)*

Trans. Am. Nucl. Soc.
*Transactions of the American Nuclear Society *(U. S.)*

Trans. Am. Ophthalmol. Soc.
Transactions of the American Ophthalmological Society *(Canada)*

Trans. Am. Soc. Metals
Transactions of the American Society for Metals *(U. S.)*

Trans. Architect. Inst. Japan
Transactions of the Architectural Institute of Japan *(Japan)*

Trans. ASME (Am. Soc. Mech. Engrs.), Ser. A: J. Eng. Power
Transactions of the ASME (American Society of Mechanical Engineers), Series A: Journal of Engineering for Power
see ***J. Eng. Power***

Trans. ASME (Am. Soc. Mech. Engrs.), Ser. B: J. Eng. Ind.
Transactions of the ASME (American Society of Mechanical Engineers), Series B: Journal of Engineering for Industry
see ***J. Eng. Ind.***

Trans. ASME (Am. Soc. Mech. Engrs.), Ser. C: J. Heat Transfer
Transactions of the ASME (American Society of Mechanical Engineers), Series C: Journal of Heat Transfer
see ***J. Heat Transfer***

Trans. ASME (Am. Soc. Mech. Engrs.), Ser. D: J. Basic Eng.
Transactions of the ASME (American Society of Mechanical Engineers), Series D: Journal of Basic Engineering
see ***J. Basic Eng.***

Trans. ASME (Am. Soc. Mech. Engrs.), Ser. E: J. Appl. Mech.
Transactions of the ASME (American Society of Mechanical Engineers), Series E: Journal of Applied Mechanics
see ***J. Appl. Mech.***

Trans. Bose Res. Inst. (Calcutta)
*Transactions of the Bose Research Institute (Calcutta) *(India)*

Trans. Brit. Ceram. Soc.
*Transactions of the British Ceramic Society incorporating British Ceramic Abstracts *(England)*

Trans. Can. Inst. Mining Met.
*Transactions of the Canadian Institute of Mining and Metallurgy and of the Mining Society of Nova Scotia *(Canada)*

Trans. Chalmers Univ. Technol., Gothenburg
*Transactions of Chalmers University of Technology, Gothenburg, Sweden *(Sweden)*

Trans. Faraday Soc.
*Transactions of the Faraday Society *(England)*

Trans. Indian Inst. Metals
Transactions of the Indian Institute of Metals *(India)*

Trans. Inst. Chem. Engrs. (London)
Transactions of the Institution of Chemical Engineers (London) *(England)*

Trans. Japan Inst. Metals
*Transactions of the Japan Institute of Metals (Sendai) *(Japan)*

Trans. Japan Soc. Mech. Engrs.
Transactions of the Japan Society of Mechanical Engineers
see Nippon Kikai Gakkai Rombunshu

Trans. Kansas Acad. Sci.
Transactions of the Kansas Academy of Science *(U. S.)*

Trans. Met. Soc. AIME
*Transactions of the Metallurgical Society of AIME (American Institute of Mining, Metallurgical, and Petroleum Engineers) *(U. S.)*

Trans. Natl. Res. Inst. Metals (Tokyo)
*Transactions of National Research Institute for Metals (Tokyo) *(Japan)*

Trans. New Engl. Surg. Soc.
Transactions of the New England Surgical Society *(U. S.)*

Trans. N. Y. Acad. Sci.
*Transactions of the New York Academy of Sciences *(U. S.)*

Trans. Ophthalmol. Soc. U. K.
Transactions of the Ophthalmological Society of the United Kingdom *(England)*

Trans. Pacific Coast Oto-Ophthalmol. Soc.
Transactions of the Pacific Coast Oto-Ophthalmological Society *(U. S.)*

Transplantation
*Transplantation (formerly Transplantation Bulletin) *(U. S.)*

Trans. Roy. Soc. Can.
*Transactions of the Royal Society of Canada *(Canada)*

Trans. Soc. Instr. Technol.
Transactions of the Society of Instrument Technology *(England)*

Trans. Soc. Pathol. Japon.
Transactiones Soc. Pathologicae Japonicae
see Nippon Byorigakkai Kaishi

Tr. Arkticheskogo i Antarkticheskogo Nauchno.-Issled. Inst., Leningrad
Trudy Arkticheskogo i Antarkticheskogo Nauchno-Issledovatel'skogo Instituta, Leningrad *(U.S.S.R.)*

Tr. Donetsk. Med. Inst.
Trudy Donetskogo Meditsinskogo Instituta *(U.S.S.R.)*

Trend Eng. Univ. Wash.
*Trend in Engineering at the University of Washington *(U. S.)*

Tr. Energ. Inst., Akad. Nauk Azerb. SSR
*Trudy Energeticheskogo Instituta imeni I. G. Es'mana, Akademiya Nauk Azerbaidzhanskoi SSR *(Azerbaidzhan S.S.R.)*

Tr. Fiz. Inst., Akad. Nauk SSSR
Trudy Fizicheskogo Instituta imeni P. N. Lebedeva, Akademiya Nauk SSSR *(U.S.S.R.)*

Tr. Gl. Geofiz. Observ.
Trudy Glavnoi Geofizicheskoi Observatorii imeni A. I. Voeikova *(U.S.S.R.)*

Tribune CEBEDEAU (Centre Belge Etude Doc. Eaux)
Tribune du CEBEDEAU (Centre Belge d'Etude et de Documentation des Eaux) *(Belgium)*

Tr. Inst. Biol., Akad. Nauk SSSR, Ural'sk. Filial
Trudy Instituta Biologii, Akademiya Nauk SSSR, Ural'skii Filial *(U.S.S.R.)*

Tr. Inst. Eksperim. i Klinich. Med., Akad. Nauk Latv. SSR
Trudy Instituta Eksperimental'noi i Klinicheskoi Meditsiny, Akademiya Nauk Latviiskoi SSR *(Latvian S.S.R.)*

Tr. Inst. Elektrokhim., Akad. Nauk SSSR, Uralsk. Filial
Trudy Instituta Elektrokhimii, Akademiya Nauk SSSR, Ural'skii Filial *(U.S.S.R.)*

Tr. Inst. Fiz., Akad. Nauk Azerb. SSR
*Trudy Instituta Fiziki, Akademii Nauk Azerbaidzhanskoi SSR *(Azerbaidzhan S.S.R.)*

Tr. Inst. Fiz., Akad. Nauk Gruz. SSR
*Trudy Instituta Fiziki, Akademii Nauk Gruzinskoi SSR *(Georgian S.S.R.)*

Tr. Inst. Fiz., Akad. Nauk Latv. SSR
*Trudy Instituta Fiziki, Akademiya Nauk Latviiskoi SSR *(Latvian S.S.R.)*

Tr. Inst. Fiz. i Astron., Akad. Nauk Est. SSR
*Trudy Instituta Fiziki i Astronomii, Akademiya Nauk Estonskoi SSR *(Estonian S.S.R.)*

Tr. Inst. Genet., Akad. Nauk SSSR
Trudy Instituta Genetiki, Akademiya Nauk SSSR *(U.S.S.R.)*

Tr. Inst. Geol. Nauk, Akad. Nauk Kaz. SSR
*Trudy Instituta Geologicheskikh Nauk, Akademiya Nauk Kazakhskoi SSR *(Kazakh S.S.R.)*

Tr. Inst. Met. im. A. A. Baikova, Akad. Nauk SSSR
Trudy Instituta Metallurgii imeni A. A. Baikova, Akademiya Nauk SSSR *(U.S.S.R.)*

Tr. Inst. Met. i Obogashch., Akad. Nauk Kaz. SSR
Trudy Instituta Metallurgii i Obogashcheniya, Akademiya Nauk Kazakhskoi SSR *(Kazakh S.S.R.)*

Tr. Inst. Okeanol., Akad. Nauk SSSR
Trudy Instituta Okeanologii, Akademiya Nauk SSSR *(U.S.S.R.)*

Tr. Inst. Onkol., Akad. Med. Nauk SSSR
Trudy Instituta Onkologii, Akademiya Meditsinskikh Nauk SSSR *(U.S.S.R.)*

Tr. Inst. Yadern. Fiz., Akad. Nauk Kaz. SSR
*Trudy Instituta Yadernoi Fiziki, Akademiya Nauk Kazakhskoi SSR *(Kazakh S.S.R.)*

Tr. Inst. Zashchity Rast., Gruz. SSR
Trudy Instituta Zashchity Rastenii, Gruzinskoi SSR *(Georgian S.S.R.)*

Tr. Inst. Zool., Akad. Nauk Kaz. SSR
Trudy Instituta Zoologii, Akademiya Nauk Kazakhskoi SSR *(Kazakh S.S.R.)*

Tr. Kishinevsk. Gos. Med. Inst.
Trudy Kishinevskogo Gosudarstvennogo Meditsinskogo Instituta *(U.S.S.R.)*

Tr. Komis. po Analit. Khim., Akad. Nauk SSSR, Inst. Geokhim. i Analit. Khim.
Trudy Komissii po Analiticheskoi Khimii, Akademiya Nauk SSSR, Institut Geokhimii i Analiticheskoi Khimii imeni V. I. Vernadskogo *(U.S.S.R.)*

Tr. Leningr. Nauchn. Obshchestva Patologoanatomov
Trudy Leningradskogo Nauchnogo Obshchestva Patologoanatomov *(U.S.S.R.)*

Tr. Leningr. Tekhnol. Inst. im. Lensoveta
Trudy Leningradskogo Tekhnologicheskogo Instituta imeni Lensoveta *(U.S.S.R.)*

Tr. Mat. Inst., Akad. Nauk SSSR
*Trudy Matematicheskogo Instituta imeni V. A. Steklova, Akademiya Nauk SSSR *(U.S.S.R.)*

Tr., Mosk. Fiz.-Tekhn. Inst.
Trudy, Moskovskii Fiziko-Tekhnicheskii Institut *(U.S.S.R.)*

Tr. 1-go [Pervogo] Vses. Soveshch. po Radiats. Khim., Akad. Nauk SSSR, Otd. Khim. Nauk, Moscow, 1957
Trudy 1-go [i. e., Pervogo] Vsesoyuznogo Soveshchaniya po Radiatsionnoi Khimii, Akademiya Nauk SSSR, Otdelenie Khimicheskikh Nauk, Moscow, March 25–30, 1957 (Pub. 1958) *(U.S.S.R.)*

Tr. Radievogo Inst., Akad. Nauk SSSR
Trudy Radievogo Instituta imeni V. G. Khlopina, Akademiya Nauk SSSR *(U.S.S.R.)*

Tr. Samarkandsk. Gos. Univ.
Trudy Samarkandskogo Gosudarstvennogo Universiteta imeni A. Navoi *(U.S.S.R.)*

Tr. Saratovsk. Med. Inst.
Trudy Saratovskogo Meditsinskogo Instituta *(U.S.S.R.)*

Tr. Sessii Akad. Nauk, Ukr. SSR po Mirnomu Ispol'z. At. Energ.
Trudy Sessii Akademii Nauk Ukrainskoi SSR po Mirnomu Ispol'zovaniyu Atomnoi Energii *(Ukrainian S.S.R.)*

Tr. Sevastopol'sk. Biol. St., Akad. Nauk SSSR
Trudy Sevastopol'skoi Biologicheskoi Stantsii, Akademiya Nauk SSSR, Sevastopol'skaya Biologicheskaya Stantsiya imeni A. O. Kovaleskogo *(U.S.S.R.)*

Tr. Smolensk. Med. Inst.
Trudy Smolenskogo Meditsinskogo Instituta *(U.S.S.R.)*

Tr. Tashkentsk. Konf. po Mirnomu Ispol'z. At. Energii Akad. Nauk Uz. SSR
Trudy Tashkentskoi Konferentsii po Mirnomu Ispol'zovaniyu Atomnoi Energii, Akademiya Nauk Uzbekskoi SSR *(Uzbek S.S.R.)*

Tr. Ural'sk Politekhn. Inst.
Trudy Ural'skogo Politekhnicheskogo Instituta imeni S. M. Kirova *(U.S.S.R.)*

Tr., Voronezhsk. Gos. Med. Inst.
Trudy, Voronezhskii Gosudarstvennyi Meditsinskii Institut *(U.S.S.R.)*

Tr. Vses. Konf. po Yadern. Reaktsiyam pri Malykh i Srednikh Enera., Moscow, 1958
Trudy Vsesovuznoi Konferentsii po Yadernym Reaktsiyam pri Malykh i Srednikh Energiyakh, Moscow, 1958 *(U.S.S.R.)*

Tr. Vses. Nauchn.-Issled. Inst. Metrol.
Trudy Vsesoyuznogo Nauchno-Issledovatel'skogo Instituta Metrologii imeni D. I. Mendeleeva *(U.S.S.R.)*

Tr. Vses. Nauchn.-Issled. Inst. Morsk. Rybn. Khoz. i Okeanogr.
Trusy Vsesoyuznogo Nauchno-Issledovatel'skogo Instituta Morskogo Rybnogo Khozyaistva i Okeanografii *(U.S.S.R.)*

Tr. 2-oi [Vtoroĭ Nauchn. Konf. po Vopr. "Probl. Zhira v Pitanii," Leningrad, 1962
Trudy 2-oi [i.e. Vtoroĭ Nauchnoi Konferentsii po Voprusu "Problema Zhira v Pitanii," Leningrad, 1962 *(U.S.S.R.)*

Tsitologiya
Tsitologiya† *(U.S.S.R.)*

Tsvetn. Metal.
*Tsvetnye Metally† *(U.S.S.R.)*

Tuberkulosearzt
Tuberkulosearzt, Der *(Germany)*

Tuberkulozis
Tuberkulozis *(Hungary)*

Tumori
*Tumori *(Italy)*

Turrialba
Turrialba *(Costa Rica)*

Tydskr. Natuurwetenskappe
Tydskrif vir Natuurwetenskappe *(S. Africa)*

TVF (Tek. Vetenskaplig Forskning)
*TVF (Teknisk-Vetenskaplig Forskning) *(Sweden)*

Uch. Zap. Leningr. Gos. Univ., Ser. Biol. Nauk
*Uchenye Zapiski Leningradskogo Gosudarstvennogo Ordena Lenina Universiteta imeni A. A. Zhdanova, Seriya Biologicheskikh Nauk *(U.S.S.R.)*

Uch. Zap. Leningr. Gos. Univ., Ser. Fiz. Geol. Nauk
*Uchenye Zapiski Leningradskogo Gosudarstvennogo Ordena Lenina Universiteta imeni A. A. Zhdanova, Seriya Fizicheskikh i Geologicheskikh Nauk *(U.S.S.R.)*

Uch. Zap. Leningr. Gos. Univ., Ser. Geol. Nauk
*Uchenye Zapiski Leningradskogo Gosudarstvennogo Ordena Lenina Universiteta imeni A. A. Zhdanova, Seriya Geologicheskikh Nauk *(U.S.S.R.)*

Uch. Zap. Leningr. Gos. Univ., Ser. Mat. Nauk
*Uchenye Zapiski Leningradskogo Gosudarstvennogo Ordena Lenina Universiteta imeni A. A. Zhdanova, Seriya Matematicheskikh Nauk *(U.S.S.R.)*

Ukr. Biokhim. Zh.
*Ukrainskii Biokhimichnii Zhurnal *(Ukrainian S.S.R.)*

Ukr. Fiz. Zh.
*Ukrainskii Fizichnii Zhurnal *(Ukrainian S.S.R.)*

Ukr. Khim. Zh.
*Ukrainskii Khimicheskii Zhurnal *(Ukrainian S.S.R.)*

Ulster Med. J.
*Ulster Medical Journal *(Northern Ireland)*

Umschau Wiss. Tech.
*Umschau ueber die Fortschritte in Wissenschaft und Technik, Die *(Germany)*

Univ. Bruxelles, Inst. Phys., Bull.
*Universite de Bruxelles, Institut de Physique, Bulletin *(Belgium)*

Univ. Minn. Med. Bull.
University of Minnesota Medical Bulletin *(U. S.)*

Urol. Intern.
Urologia Internationalis *(Switzerland)*

Urologe
Urologe *(Germany)*

Usp. Fiz. Nauk
*Uspekhi Fizicheskikh Nauk† *(U.S.S.R.)*

Usp. Khim.
*Uspekhi Khimii† *(U.S.S.R.)*

Usp. Sovrem. Biol.
Uspekhi Sovremennoi Biologii *(U.S.S.R.)*

Uzbeksk. Biol. Zh.
Uzbekskii Biologicheskii Zhurnal, Akademiya Nauk Uzbekskoi SSR *(Uzbek S.S.R.)*

Vacuum
Vacuum *(U. S.)*

Vakuum-Tech.
*Vakuum-Technik *(Germany)*

Valsalva
Valsalva *(Italy)*

VDI (Ver. Deut. Ingr.) Z.
*VDI (Verein Deutscher Ingenieure) Zeitschrift *(Germany)*

Verhandel. Koninkl. Vlaam. Acad. Wetenschap., Belg., Kl. Wetenschap.
Verhandelingen van de Koninklijke Vlaamse Academie voor Wetenschappen Letteren en Schone Kunsten van Belgie, Klasse der Wetenschappen *(Belgium)*

Verhandl. Deut. Ges. Inn. Med.
Verhandlungen der Deutschen Gesellschaft fuer Innere Medizin *(Germany)*

Verhandl. Deut. Ges. Pathol.
*Verhandlungen der Deutschen Gesellschaft fuer Pathologie *(Germany)*

Versicherungswirtschaft
Versicherungswirtschaft *(Germany)*

Vestn. Akad. Med. Nauk SSSR
Vestnik Akademii Meditsinskikh Nauk SSSR *(U.S.S.R.)*

Vestn. Akad. Nauk Kaz. SSR
*Vestnik Akademii Nauk Kazakhskoi SSR *(Kazakh S.S.R.)*

Vestn. Akad. Nauk SSSR
*Vestnik Akademii Nauk SSSR *(U.S.S.R.)*

Vestn. Cesk. Akad. Ved
Vestnik Ceskoslovenske Akademie Ved *(Czechoslovakia)*

Vestn. Dermatol. i Venerol.
Vestnik Dermatologii i Venerologii *(U.S.S.R.)*

Vestn. Leningr. Univ., Ser. Fiz. i Khim
*Vestnik Leningradskogo Universiteta, Seriya Fiziki i Khimii *(U.S.S.R.)*

Vestn. Leningr. Univ., Ser. Geol. i Geogr.
*Vestnik Leningradskogo Universiteta, Seriya Geologii i Geografii *(U.S.S.R.)*

Vestn. Leningr. Univ., Ser. Mat., Mekhan. i Astron.
*Vestnik Leningradskogo Universiteta, Seriya Matematiki, Mekhaniki i Astronomii *(U.S.S.R.)*

Vestn. Mosk. Univ., Ser. II: Khim.
*Vestnik Moskovskogo Universiteta, Seriya II: Khimiya (formerly a part of Vestnik Moskovskogo Universiteta, Seriya Matematiki, Mekhaniki, Astronomii, Fiziki i Khimii) *(U.S.S.R.)*

Vestn. Mosk. Univ., Ser. III: Fiz. Astron.
*Vestnik Moskovskogo Universiteta, Seriya III. Fiziki, Astronomii *(U.S.S.R.)*

Vestn. Otorino-Laringol.
Vestnik Otorino-Laringologii *(U.S.S.R.)*

Vestn. Rentgenol. i Radiol.
*Vestnik Rentgenologii i Radiologii *(U.S.S.R.)*

Vestn. Sel'skokhoz. Nauki, Vses. Akad. Sel'skokhoz. Nauk
Vestnik Sel'skokhozyaistvennoi Nauki, Vsesoyuznaya Akademiya Sel'skokhozyaistvennykh Nauk imeni V. I. Lenina *(U.S.S.R.)*

Vestn. Sloven. Kem. Drustva
Vestnik Slovenskega Kemijskega Drustva *(Yugoslavia)*

Vestsi Akad. Navuk Belarusk. SSR, Ser. Biyal. Navuk
Vestsi Akademii Navuk Belaruskai SSR, Seryya Biyalagichnykh Navuk *(Belorussian S.S.R.)*

Veterinariya
Veterinariya *(U.S.S.R.)*

Vet. Glasnik
Veterinarski Glasnik *(Yugoslavia)*

Vet. Record
Veterinary Record, The *(England)*

Vide
*Vide, Le. Technique-Applications *(France)*

Virginia Med. Monthly
Virginia Medical Monthly *(U. S.)*

Viroloav
Viroloav *(U. S.)*

Visn. Kiivs'k. Univ., Ser. Biol.
Visnik Kiivs'kogo Universitetu, Seriya Biologii *(Ukrainian S.S.R.)*

Voedina
Voedina *(Netherlands)*

Voenno Med. Delo
Voenno Meditsinsko Delo *(Bulgaria)*

Voennyi Vestn.
Voennyi Vestnik *(U.S.S.R.)*

Voinosanit. Pregled
Voinosanitetski Pregled *(Yugoslavia)*

Vopr. Fiziol., Akad. Nauk Azerb. SSR, Sektor Fiziol.
*Voprosy Fiziologii, Akademiya Nauk Azerbaidzhanskoi SSR, Sektor Fiziologii *(Azerbaidzhan S.S.R.)*

Vopr. Kosmogonii, Akad. Nauk SSSR
Voprosy Kosmogonii, Akademiya Nauk SSSR *(U.S.S.R.)*

Vopr. Med. Khim.
Voprosy Meditsinskoi Khimii *(U.S.S.R.)*

Vopr. Neirokhir.
Voprosy Neirokhirurgii *(U.S.S.R.)*

Vopr. Onkol.
*Voprosy Onkologii *(U.S.S.R.)*

Vopr. Pitaniya
Voprosy Pitaniya *(U. S. S. R.)*

Vopr. Radiobiol., Akad. Nauk Arm. SSR, Sektor Radiobiol., Sb. Tr.
Voprosy Radiobiologii, Akademiya Nauk Armyanskoi SSR, Sektor Radiobiologii, Sbornik Trudov *(Armenian S.S.R.)*

Vopr. Radiobiol., Sb. Tr.
*Voprosy Radiobiologii, Sbornik Trudov *(Armenian S.S.R.)*

Vopr. Rentgenol. i Onkol.
Voprosy Rentgenologii i Onkologii *(Armenian S.S.R.)*

Vopr. Rudn. Geofiz., Min. Geol. i Okhrany Nedr SSSR
Voprosy Rudnoi Geofiziki, Ministerstvo Geologii i Okhrany Nedr SSSR *(U.S.S.R.)*

Vopr. Virusol.
Voprosy Virusologii† *(U.S.S.R.)*

Vysokomolekul. Soedin.
*Vysokomolekulyarnye Soedineniya† *(U.S.S.R.)*

Wakayama Med. Rept.
Wakayama Medical Reports *(Japan)*

Waseda Daigaku Rikogaku Kenkyusho Hokoku
Waseda Daigaku Rikogaku Kenkyusho Hokoku (Bulletin of Scientific and Engineering Research Laboratory, Waseda University) *(Japan)*

Water Sewage Works
Water & Sewage Works *(U. S.)*

Welding Design Fabric.
Welding Design and Fabrication *(U. S.)*

Welding J. (N. Y.)
*Welding Journal, The (New York) *(U. S.)*

Welding Prod. (USSR) (English Transl.)
Welding Production (USSR) (English Translation of Svarochnoe Proizvodstvo) *(England)*

Weltraumfahrt
Weltraumfahrt *(Germany)*

Werkstoffe Korrosion
Werkstoffe und Korrosion *(Germany)*

Western Machinery Steel World
Western Machinery and Steel World *(U. S.)*

Wiadomosci Chemi.
*Wiadomosci Chemiczne *(Poland)*

Wiadomosci Elektrotech.
*Wiadomosci Elektrotechniczne *(Poland)*

Wiadomosci Lekarskie
*Wiadomosci Lekarskie *(Poland)*

Wien. Klin. Wochschr.
Wiener Klinische Wochenschrift *(Austria)*

Wien. Med. Wochschr.
Wiener Medizinische Wochenschrift *(Austria)*

Wien. Z. Inn. Med. Grenzg.
Wiener Zeitschrift fuer Innere Medizin und ihre Grenzgebiete *(Austria)*

Wines & Vines
Wines & Vines combined with Wine Review *(U. S.)*

Wire Wire Prod.
Wire and Wire Products *(U. S.)*

Wiss. Z. Hochsch. Maschinenbau Karl-Marx-Stadt
Wissenschaftliche Zeitschrift der Hochschule fuer Maschinenbau Karl-Marx Stadt *(Germany)*

Wiss. Z. Hochsch. Schwermaschinenbau Magdeburg
Wissenschaftlichte Zeitschrift der Hochschule fuer Schwermaschinenbau Magdeburg *(Germany)*

Wiss. Z. Humboldt-Univ. Berlin, Math.-Naturw. Reihe
*Wissenschaftliche Zeitschrift der Humboldt-Universitaet zu Berlin, Mathematisch-Naturwissenschaftliche Reihe *(Germany)*

Wiss. Z. Tech. Hochsch. Chem. Leuna-Merseburg
Wissenschaftliche Zeitschrift der Technischen Hochschule fuer Chemie Leuna-Merseburg *(Germany)*

World Health Organ., Tech. Rept. Ser.
World Health Organization, Technical Report Series *(U. S.)*

World Med. J.
World Medical Journal *(U. S.)*

Worm Runner's Dig.
Worm Runner's Digest, The *(U. S.)*

Wu Li Hsueh Pao
*Wu Li Hsueh Pao (Acta Physica Sinica) *(China)*

X-Ray Technician
X-Ray Technician, The *(U. S.)*

Yadern. Reaktsii pri Malykh i Srednikh Energ., Akad. Nauk SSSR, Tr. Vtoroi Vses. Konf., Moscow, 1960
Yadernye Reaktsii pri Malykh i Srednikh Energiyakh, Akademiya Nauk SSSR, Trudy Vtoroi Vsesoyuznoi Konferentsii, Moscow, July 21-28, 1960 (Pub. 1962) *(U.S.S.R.)*

Yakugaku Zasshi
Yakugaku Zasshi (Journal of the Pharmaceutical Society of Japan) *(Japan)*

Yale J. Biol. Med.
*Yale Journal of Biology and Medicine, The *(U. S.)*

Yao Hsueh Hsueh Pao
Yao Hsueh Hsueh Pao (Acta Pharmaceutica Sinica) *(China)*

Yogyo Kyokai Shi
Yogyo Kyokai Shi (Journal of the Ceramic Association of Japan) *(Japan)*

Yokohama Med. Bull.
*Yokohama Medical Bulletin *(Japan)*

Yosetsu Gakkaishi
Yosetsu Gakkaishi (Journal of the Japan Welding Society) *(Japan)*

Z. Aerztl. Fortbild.
Zeitschrift fuer Aerztliche Fortbildung *(Germany)*

Z. Altersforsch.
*Zeitschrift fuer Altersforschung *(Germany)*

Z. Anal. Chem.
*Zeitschrift fuer Analytische Chemie, Fresenius' *(Germany)*

Z. Angew. Entomol.
Zeitschrift fuer Angewandte Entomologie *(Germany)*

Z. Angew. Math. Mech.
*Zeitschrift fuer Angewandte Mathematik und Mechanik *(Germany)*

Z. Angew. Math. Phys.
*Zeitschrift fuer Angewandte Mathematik und Physik *(Switzerland)*

Z. Angew. Phys.
*Zeitschrift fuer Angewandte Physik *(Germany)*

Z. Anorg. Allgem. Chem.
*Zeitschrift fuer Anorganische und Allgemeine Chemie *(Germany)*

Zastosowania Mat.
*Zastosowania Matematyki *(Poland)*

Z. Astrophys.
*Zeitschrift fuer Astrophysik *(Germany)*

Zavodsk. Lab.
*Zavodskaya Laboratoriya† *(U.S.S.R.)*

Z. Biol.
*Zeitschrift fuer Biologie *(Germany)*

Z. Chem.
Zeitschrift fuer Chemie *(Germany)*

Zdravookh. Belorussk.
Zdravookhranenie Belorussii *(U.S.S.R.)*

Z. Elektrochem.
Zeitschrift fuer Elektrochemie *(Germany)*

Zentr. Allgem. Pathol. Pathol. Anat.
*Zentralblatt fuer Allgemeine Pathologie und Pathologische Anatomie *(Germany)*

Zentr. Arbeitsmed. Arbeitsschutz
Zentralblatt fuer Arbeitsmedizin und Arbeitsschutz *(Germany)*

Zentr. Bakteriol., Parasitenk., Abt. I. Orig.
Zentralblatt fuer Bakteriologie, Parasitenkunde, Infektionskrankheiten und Hygiene, Abteilung I. Originale *(Germany)*

Zentr. Biol. Aerosol Forsch.
Zentralblatt fuer Biologische Aerosol Forschung *(Germany)*

Zentr. Gynäkol.
Zentralblatt fuer Gynaekologie *(Germany)*

Zentr. Neurochir.
Zentralblatt fuer Neurochirurgie *(Germany)*

Zentr. Veterinaermed., Reihe B
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